FRDA REPORT 041

ANALYSIS OF CHANGES IN TIMBER VALUES DUE TO SILVICULTURE TREATMENTS UNDER THE CANADA - BRITISH COLUMBIA FOREST RESOURCE DEVELOPMENT AGREEMENT

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TABLE OF CONTENTS

1.0 INTRODUCTION 1

2.0 EXECUTIVE SUMMARY 2

3.0 OBJECTIVES AND BACKGROUND 4

4.0 METHODOLOGY 8
- 4.1 Configuration 8
- 4.2 Determination of Coast Stem Values 9
- 4.3 Determination of Stem Values for the Interior . . 14
- 4.4 Determination of Clear Wood Values 18

5.0 RESULTS 21
- 5.1 Determination of Coast Stem Values 22
  - 5.11 Coastal Balsam Species 23
  - 5.12 Coastal Western Red Cedar 27
  - 5.13 Coastal Douglas-fir 31
  - 5.14 Coastal Western Hemlock 35
  - 5.15 Sitka Spruce 39
- 5.2 Determination of Stem Values for the Interior . . 43
  - 5.21 Interior Douglas-fir 44
  - 5.22 Interior Spruce / Pine / Fir (spf) 48
- 5.3 Determination of Clear Wood Values 52

6.0 VALUE TRENDS 54
- 6.1 Transition to Second-growth Timber 54
- 6.2 International Factors 57
- 6.3 Price Trends of Specific Value Determinants . . . 57
- 6.4 Survey of Predictions 58

7.0 CONCLUSIONS AND RECOMMENDATIONS 59

LIST OF FIGURES

Figure No.	Description	Page
1	Division of stems into Log Modules (Coast)	12
2	Coast Douglas-fir Log Values ($/m^3)	13
3	Coast Douglas-fir Module Values ($/m^3)	13
4	Interior SPF Module Values ($/m^3)	16
5	Balsam Log Module Values ($/m^3)	24
6	Balsam Stem Values	25
7	Balsam Stem Values ($/m^3)	26
8	Cedar Log Module Values ($/m^3)	28
9	Cedar Stem Values	29
10	Cedar Stem Values ($/m^3)	30
11	Douglas-fir Log Module Values ($/m^3)	32
12	Douglas-fir Stem Values	33
13	Douglas-fir Stem Values ($/m^3)	34
14	Hemlock Log Module Values ($/m^3)	36
15	Hemlock Stem Values	37
16	Hemlock Stem Values ($/m^3)	38
17	Spruce Log Module Values ($/m^3)	40
18	Spruce Stem Values	41
19	Spruce Stem Values ($/m^3)	42
20	Interior Douglas-fir Five Metre Module Values	45
21	Interior Douglas-fir Stem Values ($/stem)	46
22	Interior Douglas-fir Stem Values ($/m^3)	47
23	SPF Five Metre Module Values	49
24	SPF Stem Values ($/stem)	50
25	SPF Stem Values ($/m^3)	51

1.0 INTRODUCTION

In October, 1987 the British Columbia Ministry of Forests together with the Canadian Forestry Service commissioned Sterling Wood Group Inc. to undertake this study.

The Canada - British Columbia Forest Resource Development Agreement (FRDA) requires that: "Canada and the Province shall jointly effect an assessment of the programs ... with regard to the stated objectives of **A Forest Sector Strategy for Canada**, the provincial forest management guidelines and this Agreement." This study forms part of and contributes to the assessment.

Funding for this study has been shared by the two signatories under the Implementation, Communications and Evaluation program within FRDA.

2.0 EXECUTIVE SUMMARY

This analysis was commissioned by the Ministry of Forests and the Canadian Forestry Service under the Canada-British Columbia Forest Resource Development Agreement. It forms part of a wider assessment of the programs funded by the Agreement.

The objective of this study was to determine the changes in value of stems of trees which may result from changes in tree size, particularly diameter, which could be promoted through various silvicultural techniques.

In conducting the analysis the consultant found a surprising lack of empirical data relating stem or log values to physical factors such as log diameter, defect or incidence of knots. Nevertheless, sufficient information was obtained from a variety of sources to provide a useful tool to any practitioner interested in assessing the increases in value that may occur from the increase in tree size prompted by silvicultural treatment.

The methods used to determine the increase in log values are fully described in this report. They are simple and, reflecting the paucity of data, no pretense at sophisticated modelling has been used.

The results are provided in a tabular and graphical form for the interior and coastal regions by major species. It was observed that overall the stem value increases with diameter in the form of a flattened "S"-shaped curve on a graph. The steep portion of the curve depicts a dramatic increase in stem value effected by diameter increase between 15 cm and 25 cm. This reflects a considerable improvement in lumber yield that occurs as a result of the size change.

Traditionally, clear knot-free lumber has been able to command premium prices in the market place. Included with the results are

tables which provide the means for the practitioner to determine increases in value of a stem which will occur given an expected increase in value to a butt log improved by pruning.

The report also discusses trends in values and the conclusions to be drawn indicate that values will increase in real terms and that the practitioner should be optimistic about the future value of both coniferous and deciduous species of trees grown in British Columbia.

3.0 OBJECTIVES AND BACKGROUND

The study objective was to determine the changes in value of stems of trees of the major species in British Columbia resulting from changes in tree size, particularly diameter. The results are to serve as a reference for the determination of commercial value benefits attributable to the achievement of growth through application of silvicultural prescriptions.

Silvicultural prescriptions employed in the practice of intensive forest management are expected to enhance the productivity and increase sustainable yields from the land base. Measurement of these improvements is often done in terms of physical productivity gains that result from a treatment or various intensities of a treatment.

It is more appropriate to evaluate the benefits derived from investment in silvicultural treatments in terms of the value of the forest than by volume alone.

> "...investments in intensive forest management should not be evaluated in terms of physical criteria such as maximizing the volume of timber through time from a particular site... The question is whether such investments represent the most efficient allocation of society's scarce resources. Consequently, the appropriate criterion for assessing the desirability of investments in intensive forest management is economic." (Percy, 1986)

Terms of reference required the determination of stem values through a range of appropriate heights and diameters for major B.C. species and for coast and interior regions. In addition to value changes with height and diameter, the value of achieving knot-free clear wood increments to the stem were to be determined. The project did not require the gathering of original data. The approach was to be empirical, using published data, industry and government sources and "best judgement" of the consultants. Stem values would be current, expressed in constant Canadian dollars with 1986 to be used as a base year.

Early in the project it became evident that available base-line data relating to the study are surprisingly scarce. In addition, practical computer techniques, such as growth simulation, are in the process of refinement by some agencies but are not yet available in a form usable for this application.

For the study, all known literature was reviewed, many researchers and practitioners were interviewed and all known accessible data gathered. Sources and persons interviewed are listed in Appendix I.

One of the value changes that the Consultant addressed relates to pruning and the resultant "collar" of clear wood that this silvicultural activity is intended to produce. Several attempts were made to determine the value of clear wood increment to the bole of a tree achieved by pruning but this proved to be elusive because of a lack of data. Specifically, the Consultant was unable to find information showing the volume recovery of clear lumber grades that may be produced from a range of thicknesses of clear collar. In attempting to obtain value increments for this clear collar three potential information sources were examined as follows.

(a) The subject literature. Published study results were found to be insufficient and too inconsistent to establish value increments across the range of diameters addressed by this study.

(b) Computer simulation models. While there is potential for this technique to provide the needed information, no suitable models were available and there was neither time nor funding to develop an appropriate model or to modify an existing one.

(c) Parallel data for old-growth wood. The Consultant possesses data showing the recovery of clear lumber grades to be expected from efficient sawing of old-growth stems. It was hoped that these could be adapted for application to second-

growth stems but, upon examination, it was found that the data reflects old-growth characteristics very different to those of second-growth pruned stems. In the old-growth stems the clear wood component is often asymmetrically contained within the bole which contrasts with the smaller pruned second-growth stems which usually contain a more symmetric and concentric collar of clear wood.

Despite these shortcomings it was possible to calculate the incremental value of the stem if the incremental value of the pruned portion was known (see Tables 5.31 to 5.35). Thus a practitioner who is able to estimate the value of clear wood recovery from butt logs in a pruning scenario specific to his circumstances can use this study to determine the value effect upon whole stems.

Because of the paucity of data, we have made necessary assumptions, extrapolations and interpolations within the report based on our professional judgement and these are noted.

The core of the report consists of sets of tables and graphs, by species, for interior and coastal forest stands. These provide numerical value increments for diameter and height changes which might result from silvicultural treatments. An additional set of tables addresses value increments for the production of clear wood value and "uppers" (i.e. from pruning). These latter tables are provided only for coastal Douglas-fir stands and are based on very limited data because no other exist. Douglas-fir stands are the most likely candidates to receive such treatment in the foreseeable future, but if similar information is sought for other species it too can be developed. The tables and graphs in the report are useful to the practitioner in that once the physical effect of a specific silvicultural treatment has been determined or projected, the value effect of that treatment can also be determined. This in turn allows a financial analysis of cost to benefit or of rate of return.

In addition to, and independent of the provision of numerical data, the consultants were requested to comment on perceived value trends of forest products. This has been done in the report in a subjective manner and the opinions and conclusions are solely those of the consultants.

4.0 METHODOLOGY

4.1 Configuration

The study was split into two separate sections, one for the coast and one for the interior. The distinction between these two regions is broadly recognized administratively by all agencies and especially by the B.C. Ministry of Forests. Stumpage appraisal systems differ distinctly between the coast and interior chiefly because the primary market for forest products is reached at the log level on the coast, while it is at the dimension lumber level in the interior. On the coast there is an active log market wherein some seven million cubic metres are bought and sold annually.[1] This market and the history of prices it provides is a basis from which to value timber on the coast. Moreover, the complexity and diversity of the coastal milling infrastructure inhibits determination of timber values using an end-product system as is used in the interior.

There is no general log market in the interior, hence the primary market for forest products is dimension lumber. Pulp chips also contribute to primary revenues, but market prices are not published, and the revenues are commonly treated as a by-product offset against production costs. For the purpose of this study, the value of the merchantable stem delivered to the mill gate was calculated by deducting conversion costs (net of chip revenue) from the average market value of lumber recovered (see Appendix II, Table 3).

For representative pricing, a 10-year (1978-1987) historical average of all costs and prices was used in this study in order to minimize the influence of economic cycles. All

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[1] Source: Valuation Branch, Ministry of Forests and Lands.

dollars are expressed in constant (1986) Canadian currency unless indicated otherwise.

4.2 Determination of Coast Stem Values

Logs bought and sold in the coast log market are priced according to their species and grade. Top-end diameter is one of the chief parameters of the grading system and it is possible to trace the change in log price with changes in diameter criteria. Generally, price varies directly with diameter. There are three values associated with larger diameters which are pertinent here: first, the value of the potential to recover lumber of increasing dimension; second, the value of the potential to extract more aesthetically appealing products, such as clear lumber; and third, there is the value of the effect of increasing diameter on the additional recovery of lumber.

The values determined here are to be applicable to second-growth balsam fir, western red cedar, Douglas-fir, western hemlock and sitka spruce. The log values used to determine stem values were derived from records of log sales comprising mostly old-growth timber. The relevance of using old-growth prices to value second-growth stems is open to question. In B.C.'s coast log market, and within the diameter ranges considered in this study, there is little solid evidence on which to adjust the value of average quality second-growth relative to average quality old-growth. However, a study in the Pacific Northwest United States comparing lumber yields from old- and young-growth Douglas-fir found little if any difference between the two types.[1] Hence, the use of unadjusted market log values was

[1] Ernst, S. and Fahey, T.D. "Changes in Product Recovery of Douglas-fir from Old-growth to Young-growth." Douglas-fir: Stand Management for the Future. (pp 103-107)

considered valid and as accurate as is reasonably attainable at this time.

Logs are graded according to the Ministry of Forests alpha nomenclature , A through Y, and the majority of volume falls into a narrow range of grades namely, D, H, I and J (plus shingle grades for western red cedar). By way of example, Douglas-fir top-end diameter criteria (with exceptions for short logs) for these grades are:

D: >=76cm.
H: >=30cm.
I: >=38cm.
J: >=10cm.,<=36cm.

H-grade specifications permit smaller and fewer knots than I-grade, hence, although the minimum diameter is lower, it has the potential to yield higher lumber grades and more value. In fact the average diameter of all H-grade is higher than the average for I-grade logs, even though H-grade has a lower permissible minimum diameter. It is generally acknowledged that the price for J-grade and most I-grade reflects construction lumber recovery, while H-grade and D-grade values reflect the expected recovery of a combination of construction and clear lumber. Log length information for the logs contributing price data was unavailable.

Prices tend to rise rapidly through the lower diameters, then plateau through a range until clear recovery expectations are reflected in another strong upward price movement. (See fig. 2, page 13).

The diameter classes applicable to second-growth lie mainly at the lower end of the range (10cm to 30cm) where prices increase rapidly with diameter. This range is represented chiefly by J-grade logs. Unfortunately, this is the only log

grade formally identified in this diameter range[1], and so a price gradient is not available from published prices. However, there is a trade practice in the coast log market that further differentiates J-grade logs into specialized log sorts. On the lower diameter end of this spectrum is the so called "chip-n-saw" sort, and at the upper end is the "large gang" sort. Prices and average diameters for these sorts have been obtained from industry sources. Using this information, it was possible to establish a price gradient through the J-grade range of diameters with the exception of sitka spruce where there is no established market for small log specialty sorts.

Average diameters attributable to average log prices were unavailable from the B.C. Ministry of Forests. Diameter statistics were obtained from the consultants' files and from industry scaling records. Log prices for a range of diameters from 14 cm. to 50 cm., in 1 cm. increments, were interpolated from the data accumulated. These prices were then used to price the log sections (modules) within each stem definition valued. The range of stem sizes valued was from a diameter at breast height (dbh) of 20cm. up to 50cm. in 5cm. increments, and heights of 20m. to 40m. in 5m. increments. The diagram overleaf illustrates the division of the stem into the stump, the merchantable stem (wherin lie the log modules) and the unmerchantable stem top. The graphs on page 13 show the log value base data and the derived module values for coast Douglas-fir.

A computer model devised by the consultant was used to approximate the maximum potential value of the merchantable stem as a sum of the log modules extracted.

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1 Except X and Y grades which, because they reflect the decadent component, are considered to be insignificant in the context of second-growth.

Fig. 1

DIAGRAMATIC REPRESENTATION OF THE DIVISION OF COAST STEMS INTO LOG MODULES

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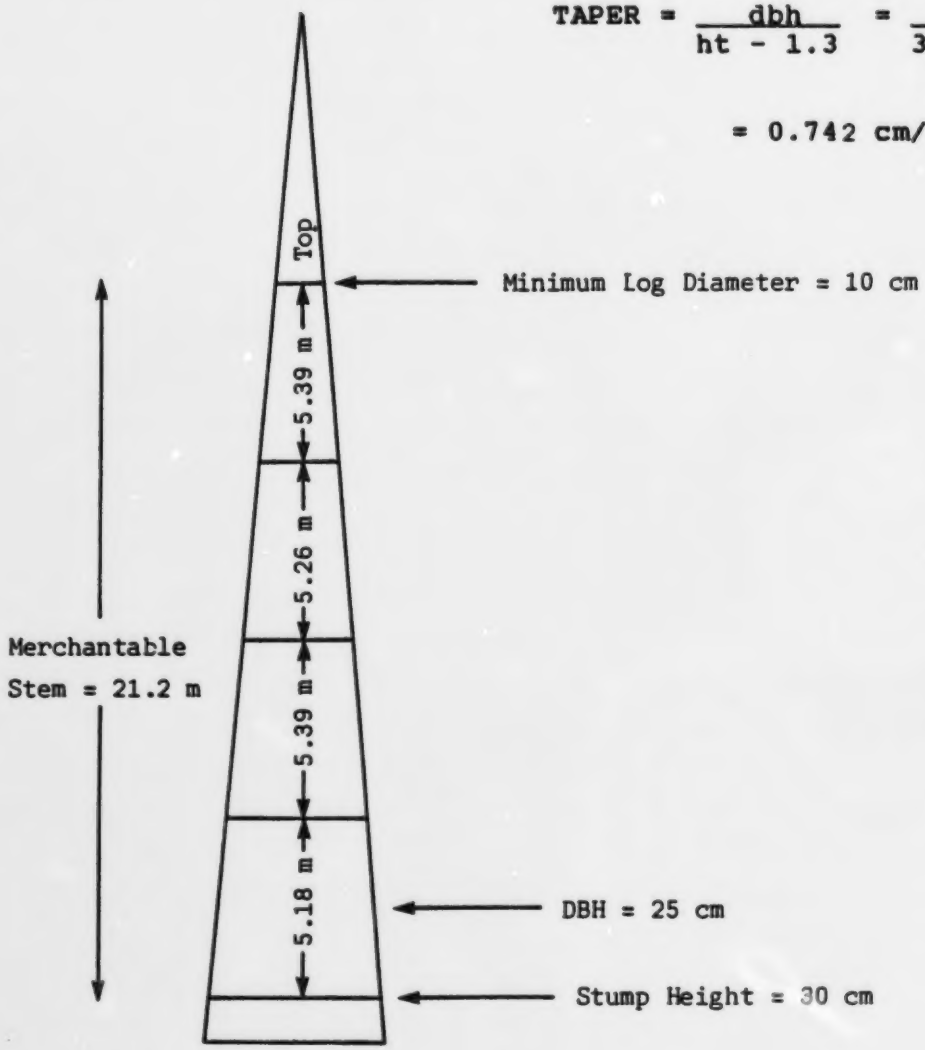
Example for a tree with a height of 35 metres and d.b.h of 25 cm.

$$\text{TAPER} = \frac{\text{dbh}}{\text{ht} - 1.3} = \frac{25}{35 - 1.3}$$

$$= 0.742 \text{ cm/m}$$



Note: Diagram not to scale

COAST DOUGLAS–FIR LOG VALUES ($/m3)

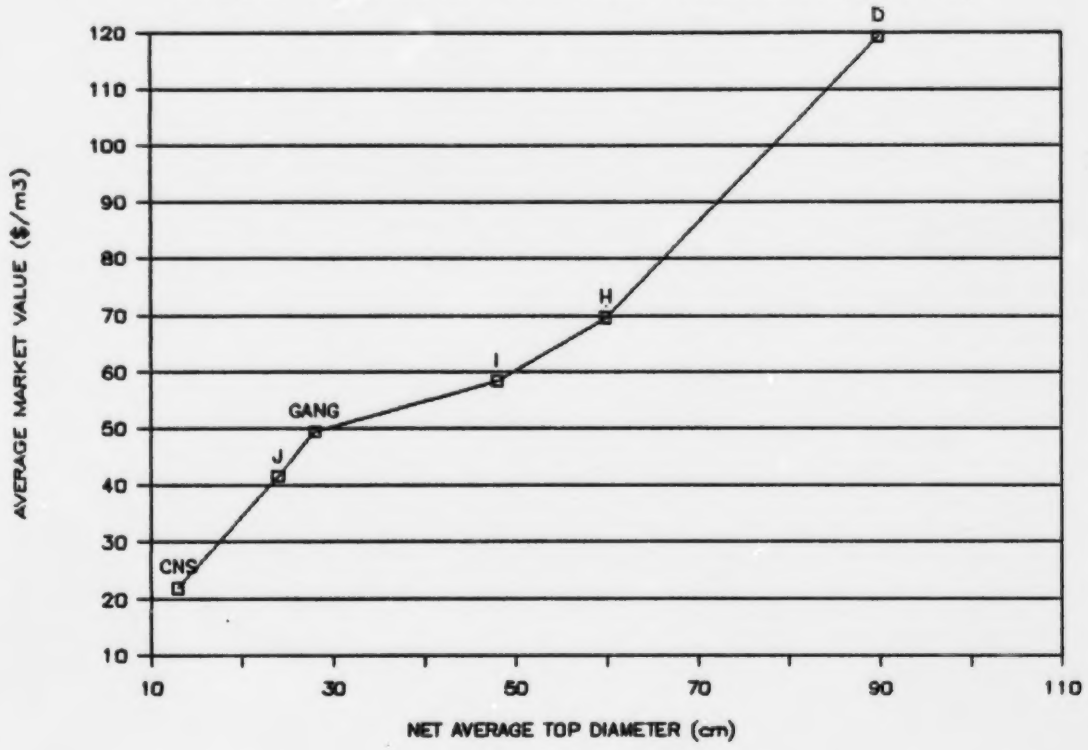


Fig. 2

COAST D–FIR MODULE VALUES ($/m3)

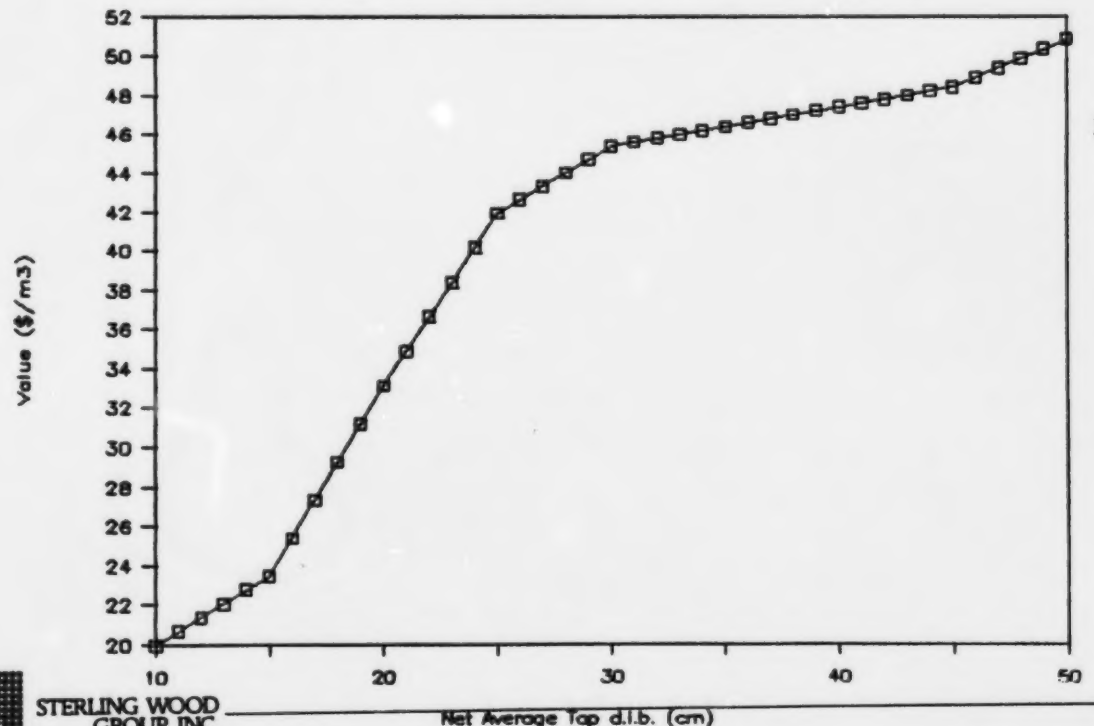


Fig. 3

4.3 Determination of Stem Values for the Interior

The determination of values of stems delivered to the mill gate required deduction of conversion costs from, and addition of by-product values to the lumber product value of each diameter class.

An estimate of product yields from each diameter class was needed in order to assign a sales revenue to each. Scarcity of this type of data is well documented (Middleton,1985). Fortunately, a rigorous analysis of interior Douglas-fir recoveries has been undertaken in British Columbia by the Joint Interior Product Outturn Committee (JIPOC) and the results published by Forintek in 1985. Although similar data were not available for spruce/pine/fir (SPF), the consensus of opinion among experts in industry and at Forintek was that, in second-growth timber, similar lumber recoveries could reasonably be expected from both Douglas-fir and SPF but chip recovery would differ because of variances in specific gravity between species.

It was possible to consult with Forintek personnel who possessed intimate knowledge of the JIPOC study, and who advised the consultants on matters of interpretation and use of the information contained in the published report. The information drawn from this data source was selective and represented the best available data for a contemporary, modern interior sawmill cutting second-growth timber.

Log quality criteria derived from the JIPOC study for the better quality trees approximated second-growth, managed stand quality expectations, i.e.

* No conks.
* No dead or broken tops.
* No fork or crook in lower two-thirds of the tree.

* No scars, rotten branches greater than 10cm. in diameter or frost cracks in lower third.
* No major (greater than 10 degrees) sweep or lean.
* Taper, (dbh / height(cm)) less than 1:48.

Product recoveries for each diameter class in the JIPOC study data were multiplied by lumber prices to determine the gross sales value for each. Prices, expressed in constant 1986 dollars[1], were an average of the ten years 1978-1987 as published by Random Lengths and/or Madisons Lumber Reporter.

A residual value to the mill gate was calculated for each diameter class by deducting conversion costs and adding a pulp chip revenue (see Appendix II, Table 3). A constant conversion cost of $84.00/m3 and a constant chip return of $50.00/bdu was used. Conversion costs were given careful scrutiny in light of potential variability with log sizes and mill configuration.

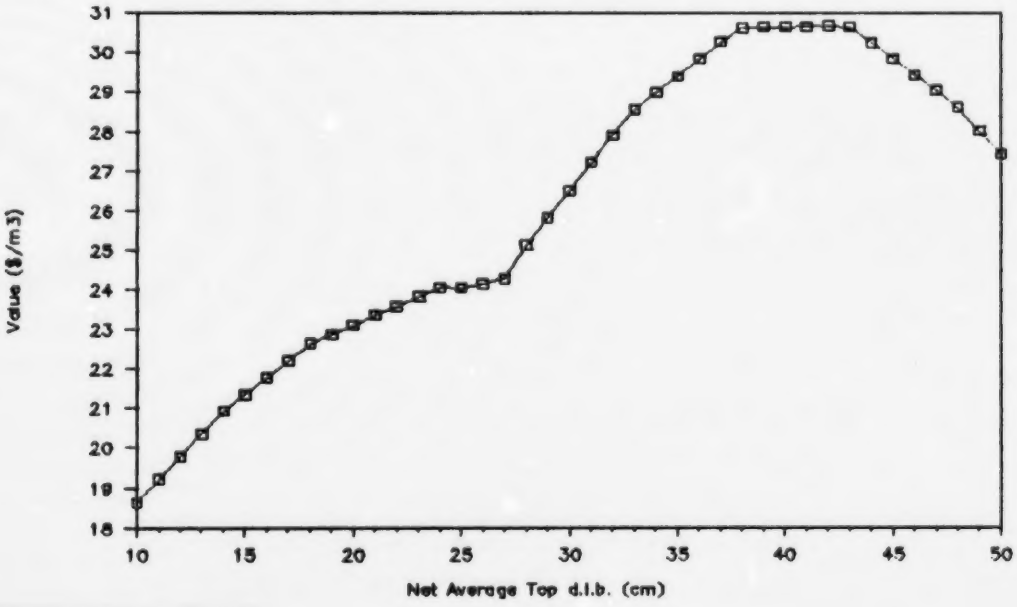
Interior sawmill conversion costs used in the determination of log value at the mill gate were found by averaging the costs of a broad selection of interior sawmills over the past 10 years , and converting to 1986 dollars. No adjustments were made to costs per Mfbm to reflect cost changes with diameter because it was found there was a wide divergence of opinion among industry experts whether the cost of converting small logs differs appreciably from that of logs with larger diameters, providing the log is being converted in the manner most efficient for its size. Information was also provided which indicated that small log mills incur average costs that are approximately 10 percent lower per Mfbm than for dimension mills cutting a full range of sizes. However, it has been maintained in a recent publication that milling costs increase by as much as 65

1 Implicit Gross National Product Price Deflator, Statistics Canada.

percent when log diameter decreases from 30.5 cm to 15.2 cm (Fight and Briggs, 1986).[1] The conversion cost used is a compromise of actual historical rates and the expected costs that would be incurred by a contemporary modern mill. Recovery rates for pulp chips were derived from J. Dobie, 1978, and the price was set at an average for the base period after consultation with knowledgeable industry sources verified by comparison to the Consultant's confidential records.

The values of logs by diameter class were thus determined and a table of interpolated values by diameter was developed for diameters 10cm. through 50cm. in 1cm. increments. The following graph provides an example.

Fig. 4 INTERIOR SPF MODULE VALUES ($/m3)



[1] In order to deal with this controversy, interior Douglas-fir stem values were subjected to a sensitivity analysis in which stem values were calculated at rates based on an increase between 0% at 18 cm. top diameter and 50% for logs with a top diameter of 12.4 cm. Costs for values between 10 cm. and 18 cm. were interpolated from these adjusted values. The resulting stem values are presented in Appendix III.

A computer model was used to calculate the top diameters of 5m. modules for a desired array of stems. This array was to cover a broad spectrum of interior second-growth possibilities, having height classes of 15m to 40m. in 5m increments, and a dbh range of 20cm. to 50cm in 5cm. increments. For each 5m. log module, an appropriate value ($/m3) was assigned from the table of values previously determined. The model functioned by sectioning the stem into 5m. logs and calculating top diameter and volume of each piece. It then matched the appropriate values to log diameters and summed the component module values to determine stem value. Residual lengths under 5m. were taken from the top of the stem and if under 2.5m. were priced at chip revenue less a processing cost.

Examples of the method of derivation of stem values for each of the interior and coastal areas are presented in Appendix II.

4.4 Determination of Clear Wood Values

Pruning of commercial timber stands has long been considered as a means of improving the quality of the final crop by increasing the potential to recover clear wood. Recently, it has also been considered as a prescription for reducing the amount of juvenile wood produced.

There are only a few published studies of pruning benefits in B.C. and the Pacific Northwest States, and only two are of sufficiently large sample size to be of practical value. A pruning experiment in B.C. involving 270 pruned and 366 unpruned Douglas-fir logs resulted in "... marked negative benefits to product values..." hence a net negative result. (Dobie and Wright, 1978). The stand was pruned at age 33 and harvested at age 53. In another experiment conducted in the Pacific Northwest and known as the Voight Creek study (Cahill, Snellgrove and Fahey, 1984) it was found that pruning achieved a 10 percent increase in the value of Douglas-fir logs sawn to lumber, and a 30 percent increase in the value of similar logs peeled to veneer. Results showed an essentially constant percentage improvement over diameters ranging from 25 cm to 51 cm.[1]
The latter study involved processing of 197 pruned logs and 100 unpruned logs from a stand with site index ranging from 100 to 170. The stand was pruned at approximate age 38 and harvested 34 years later. It had been pruned to a height of 17 feet and had been thinned at varying intensities yielding an average clear shell radius increment of 7.9 cm.

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[1] It is evident that the value increases indicated in the Voight Creek study report were based on gross revenues of final product. Percentage improvement would likely be higher at the log value level depending upon treatment of allowance for profit and risk.

The intent of this report is to provide a reference for the purpose of estimating value difference as a result of applying silvicultural treatments to timber stands. On this basis, the published information indicates highly variable outcomes for pruning regimes and offers only an indication of potential for gain. Use of a computer simulation to develop tables indicating a broad range of potential returns from pruned stands was considered but rejected as being beyond the terms of reference for this study.

There are two steps to be taken by the practitioner in developing estimates of financial benefits resulting from the application of pruning treatments :

1. Estimate the end product value increment as a result of the treatment.
2. Relate value increments to the stand.

The end product value increment is dependant upon a multiplicity of variables impinging upon the growth of a clear wood collar onto the bole. The geometric determinants of incremental clear lumber or veneer recovery include the diameter of the bole when the tree was pruned, the diameter when it was harvested, and the height to which it was pruned. Coincident with these basic variables, evaluation of expected benefits as a result of pruning treatments require consideration of growth rates (ring widths) and estimates of pruning scars or pitch pocket defect penetration within the clear collar. It is insufficient to estimate the gross volume of clear wood in the collar and extend it to the value gain on a simple volumetric basis. Recovery of clear wood expressed as a percent of the total lumber or veneer recovery from the log is fairly constant with stem diameter but varies non-linearly with the width of the clear collar. The difficulties in the prediction of value are further compounded by premium prices for thicker and wider cuttings.

Consequently, it is evident that the determination of increases to end product returns from pruning are better determined specifically for each circumstance.

At this juncture the forest manager, upon arriving at an ad hoc estimate of the value increment to the pruned log, can use the results displayed in section 5.3 of this report to determine a value increment to the whole stem. This will provide a basis to link pruning benefits to the stand. For example, if it were estimated that a pruning treatment was to result in a 20 percent increase to the value of product generated from the pruned portion of the stem (the butt log), and thereby generate a 30 percent increase to the value potential to that log[1] , stem values would have to be recalculated with an addition of 30 percent to the value of the butt log on each stem. For the purpose of this report, stem values for unpruned trees were recalculated to simulate pruned trees, and the value increments to the stem were determined in increments of 15 percent to the butt log, up to a maximum of 75 percent. It was assumed that the stem would be pruned to a height of 5.2 metres. Tables showing the resulting percentage value differentials between pruned and unpruned Douglas-fir stems, and for a full range of diameters and heights are presented on page 53.

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[1] Note: a higher value percentage to the log results from applying the revenue increment after deducting conversion costs.

5.0 RESULTS

It is expected the results presented herein will provide a means for the determination of value differentials between stem growth scenarios. Stem values were presented as they "fell out" in the analysis and no mathematical smoothing was employed as it would not have added to the results. These results represent the value of the merchantable stem delivered to the point at which the converting mill would purchase logs. In the interior this would be to the mill inventory, or "at the mill gate", while on the coast it would be at a common transfer point such as Howe Sound. Values do not include an accounting for any costs incurred prior to the point of sale, nor do they include allowance for profit and risk. The user may employ his own regressions if continuous mathematical relationships are required.

Wherever available, log and stem values as they change with diameter were compared to published results. The scant information published on this subject derives mostly from the U.S. Pacific Northwest and concerns Douglas-fir. Furthermore, none of these publications carried the analysis back to the merchantable stem, although Fahey et al. (1974) did determine values for woods length logs, and Session et al. (1985) related values to the stand. It was found that these published log values tended to follow the same general value relationship with diameter, showed similar rates of change and showed the similar points of inflection as found herein. FRDA report No.014[1] provides a table of wood values which lists lower values in the diameter range between 15cm. and 45cm. than is shown in the results of this report. That data source has not been analysed to determine the reasons for the differences.

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[1] Impact of Intensive Forestry on Net Stand Values in British Columbia. Nawitka Resource Consultants. FRDA report No.014, 1987.

5.1 Determination of Coast Stem Values

Coast log prices tend to increase rapidly from their lowest levels, found at minimum diameters, to a point somewhere in the range of 30 cm where they continue to increase at a modest rate, if at all, until at about 50 cm they resume their rapid ascent. This general pattern of price in relation to diameter is explained by the rapid improvement (albeit at a diminishing rate) in recovery, product value and productivity in sawmills as the diameter of log inputs increases through the lower range. The flattening effect of diminishing returns is then overtaken somewhere near the 40-50 cm range where recovery of clear products from the better grades of log becomes evident.

This report addressed stem diameter (dbh) ranges from 20 to 50 cm as pertinent to second growth stands. The log values determined were assigned to log sections of hypothetical stems according to an assumed bucking pattern.

The sheaf of curves reflecting individual stem values for each species indicates a trend to higher stem value with tree diameter measured at breast height. Values increased at an accelerated rate with height, as would be expected.

The curves reflecting value per cubic metre with changes in diameter and height generally follow a similar and almost common line, thus reflecting little effect due to height. Stem values increased at a diminishing rate with increasing diameter, consistent with log value trends at diameters less than 50 cm. The 20 metre height class deviated from the apparent common line at lower diameters where fewer logs could be obtained from stems of equal diameter but greater height class.

5.11 Coastal Balsam Species

STEM VALUE ($ per whole stem)

DBH (cm)	Tree height in metres 20	25	30	35	40
20	$ 4.78	$ 6.59	$ 8.00	$ 9.22	$10.62
25	9.52	12.13	14.33	16.79	19.03
30	14.95	18.96	22.45	26.67	30.12
35	23.39	28.63	35.01	39.91	44.94
40	33.08	39.63	47.30	56.20	63.15
45	42.43	54.09	61.85	71.03	82.05
50	53.90	68.42	81.99	92.50	103.67

STEM VALUE ($ per cubic metre)

DBH (cm)	Tree height in metres 20	25	30	35	40
20	$25.53	$25.84	$26.82	$26.77	$27.29
25	27.23	28.87	28.80	29.39	29.35
30	28.78	30.41	30.40	31.50	31.30
35	33.42	33.21	34.60	34.06	33.63
40	35.69	34.76	35.48	36.35	36.01
45	35.91	37.12	35.61	36.09	36.78
50	36.78	37.75	37.94	37.96	37.41

Fig. 5

BALSAM LOG MODULE VALUES ($/m3)
Value ($/m3)
0
10
20
30
40
50
10
20
30
40
50
Top Diameter (cm inside bark)
STERLING WOOD GROUP INC.

STERLING WOOD GROUP INC.

BALSAM STEM VALUES

(WHOLE STEMS)

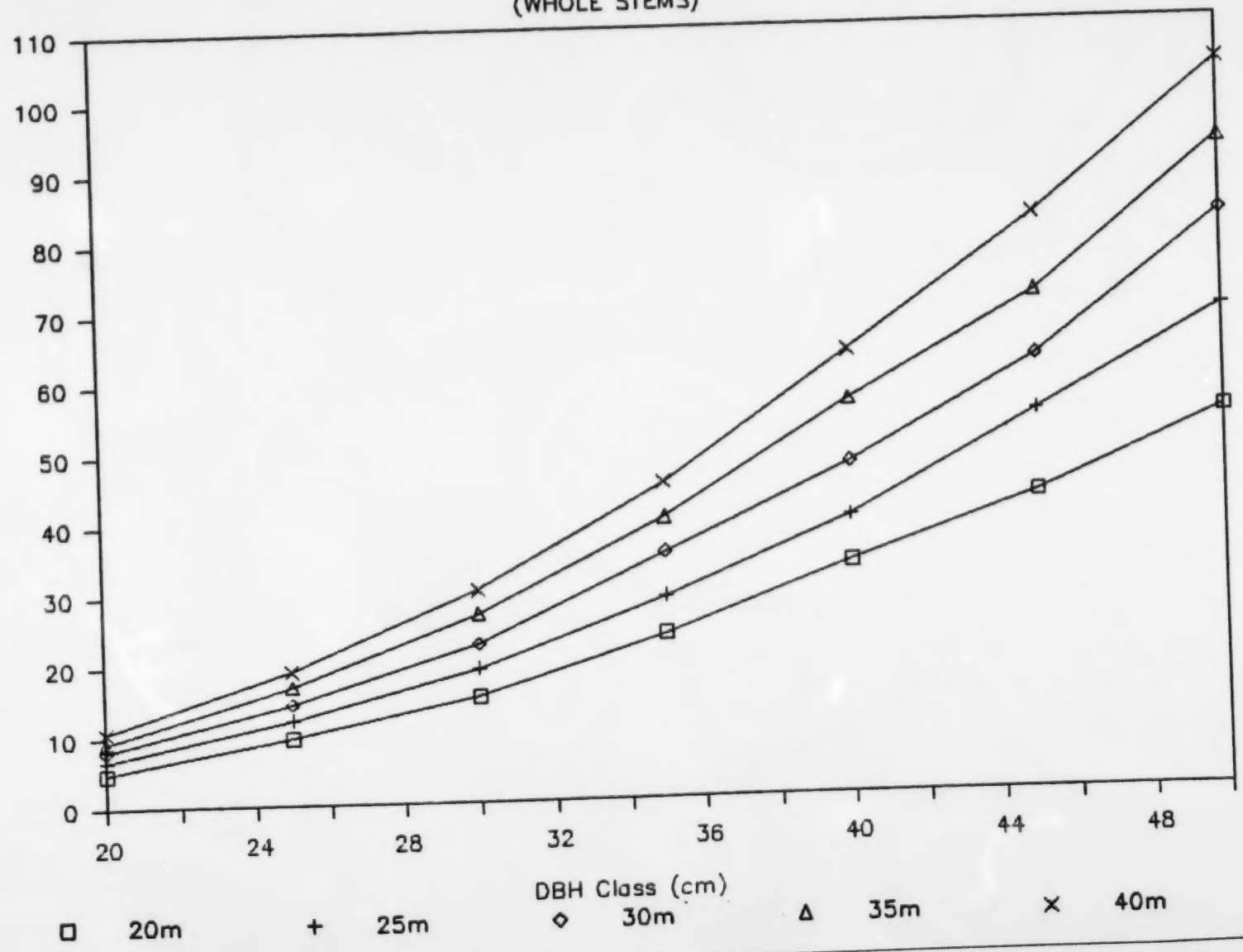


Fig. 6

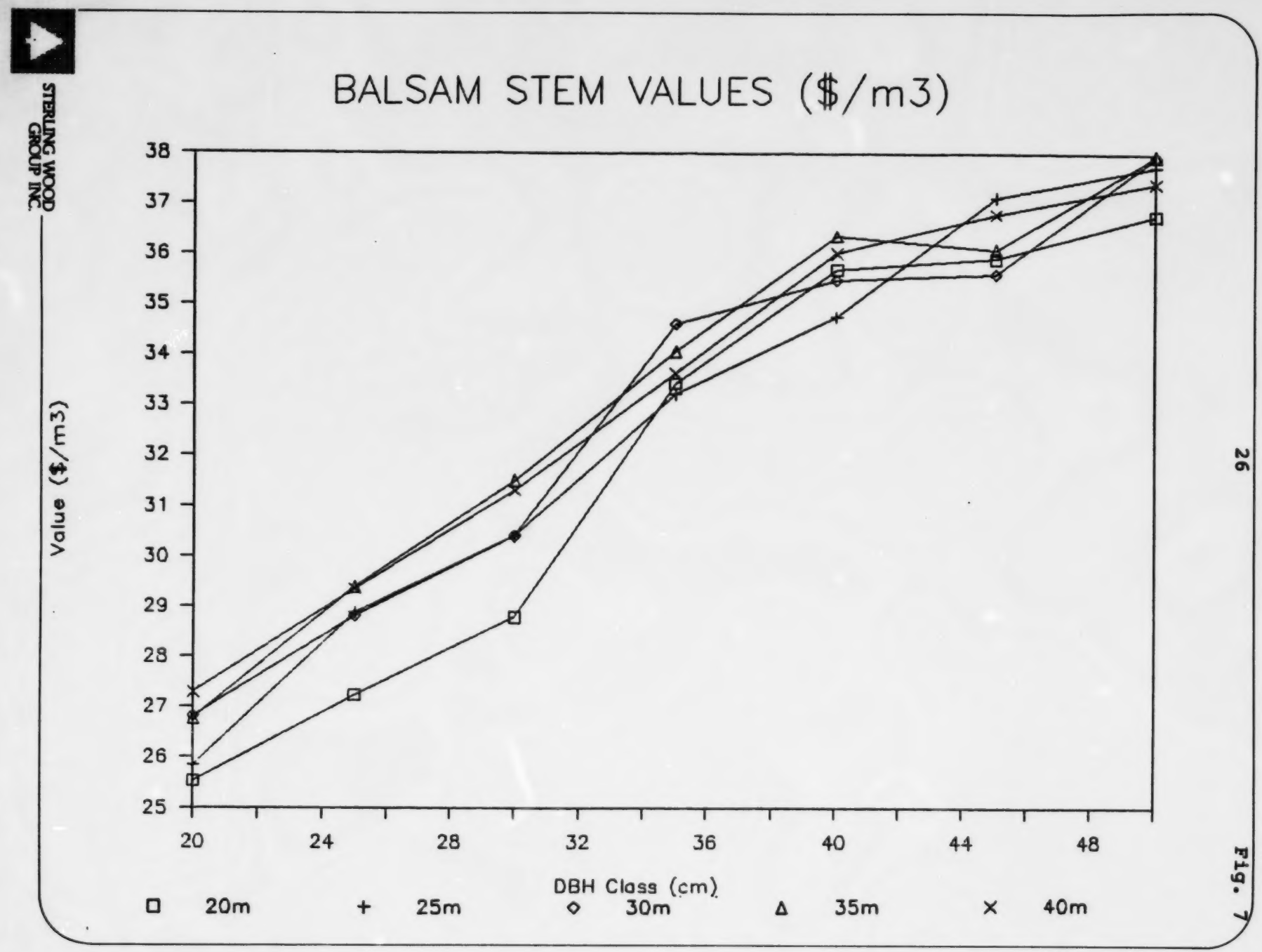

BALSAM STEM VALUES ($/m3)
STERLING WOOD GROUP INC.
Value ($/m3)
38
37
36
35
34
33
32
31
30
29
28
27
26
25
20
24
28
32
36
40
44
48
DBH Class (cm)
□ 20m
+ 25m
◇ 30m
Δ 35m
× 40m

Fig. 7

5.12 Coastal Western Red Cedar

STEM VALUE ($ per whole stem)

DBH (cm)	Tree height in metres 20	25	30	35	40
20	$ 3.69	$ 5.90	$ 6.94	$ 8.35	$10.20
25	10.44	14.20	16.69	20.20	22.83
30	18.78	26.23	31.13	36.71	41.77
35	31.39	39.51	47.62	55.88	62.20
40	44.59	55.82	67.76	78.46	88.99
45	59.66	74.69	89.91	103.55	116.93
50	75.85	95.12	114.06	129.81	149.04

STEM VALUE ($ per cubic metre)

DBH (cm)	Tree height in metres 20	25	30	35	40
20	$19.77	$23.13	$23.00	$23.87	$26.23
25	29.88	33.77	33.53	35.35	35.20
30	36.14	42.07	42.16	43.36	43.41
35	43.58	45.83	47.07	47.69	46.54
40	48.10	49.05	50.83	50.75	50.75
45	50.50	51.26	51.76	52.62	52.42
50	51.75	52.49	52.78	53.28	53.79

STERLING WOOD GROUP INC.

CEDAR LOG MODULE VALUES ($/m3)

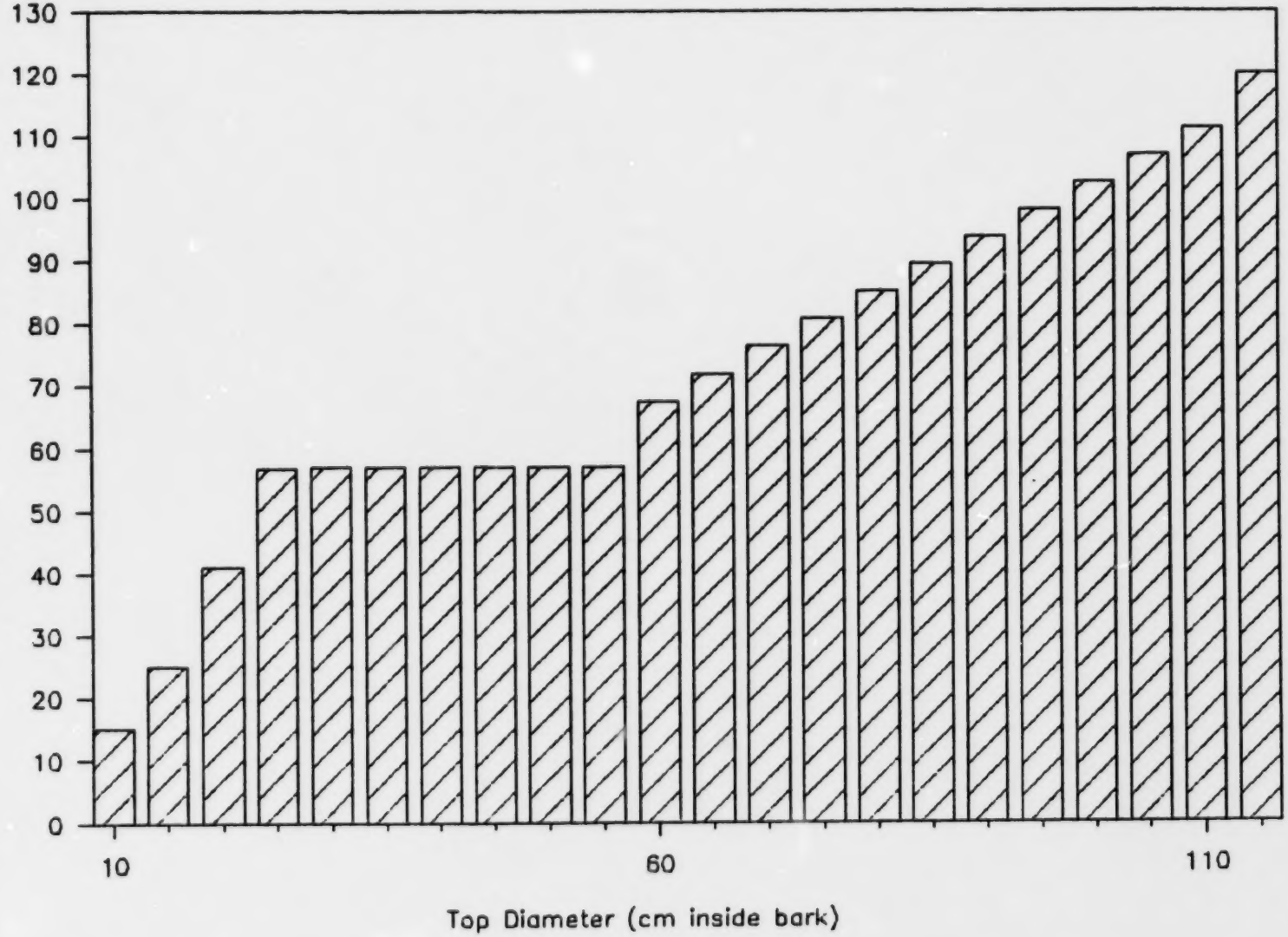
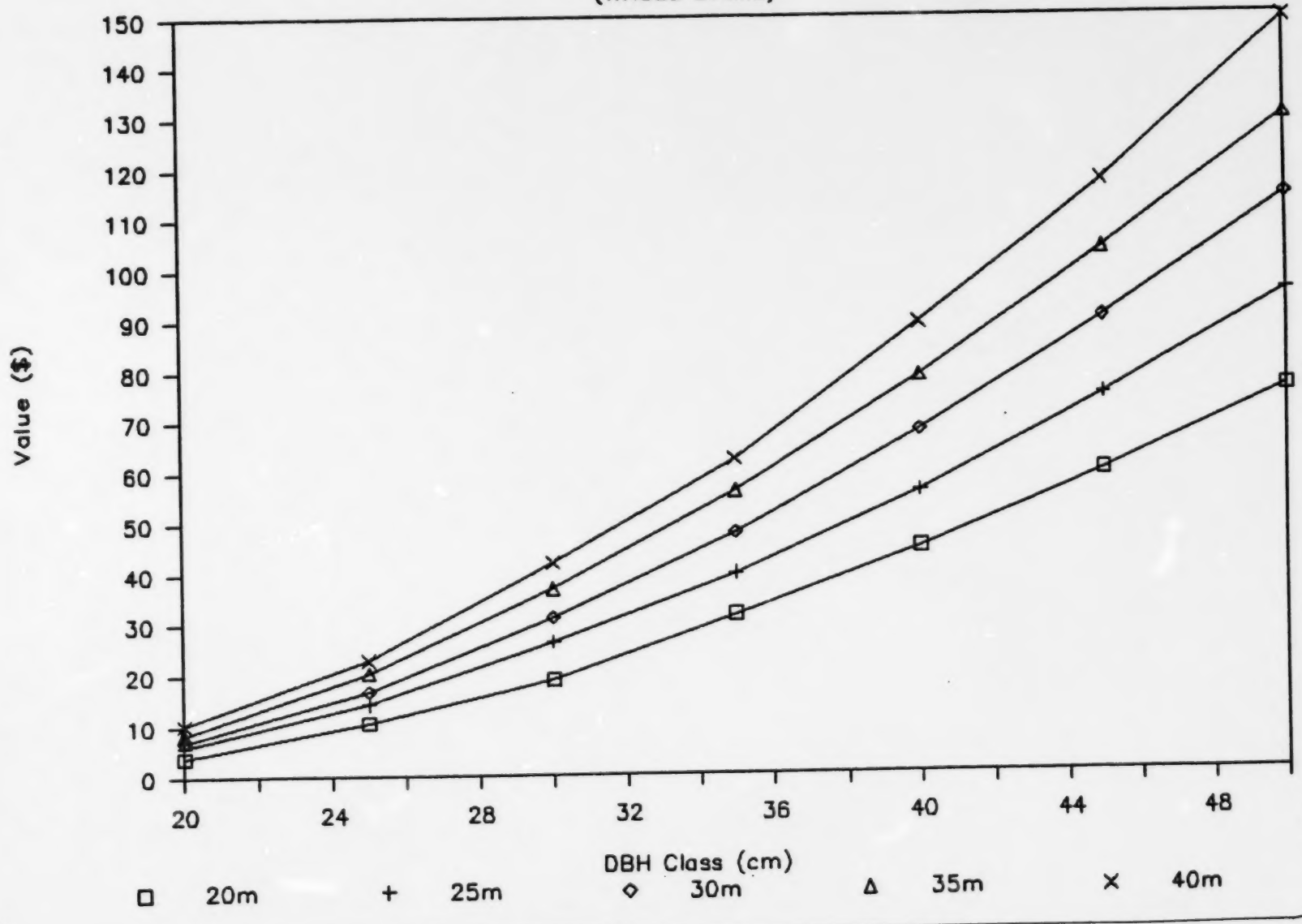


Fig. 8

STERLING WOOD GROUP INC.

CEDAR STEM VALUES

(WHOLE STEMS)



29

Fig. 9

STERLING WOOD GROUP INC.

CEDAR STEM VALUES ($/m3)

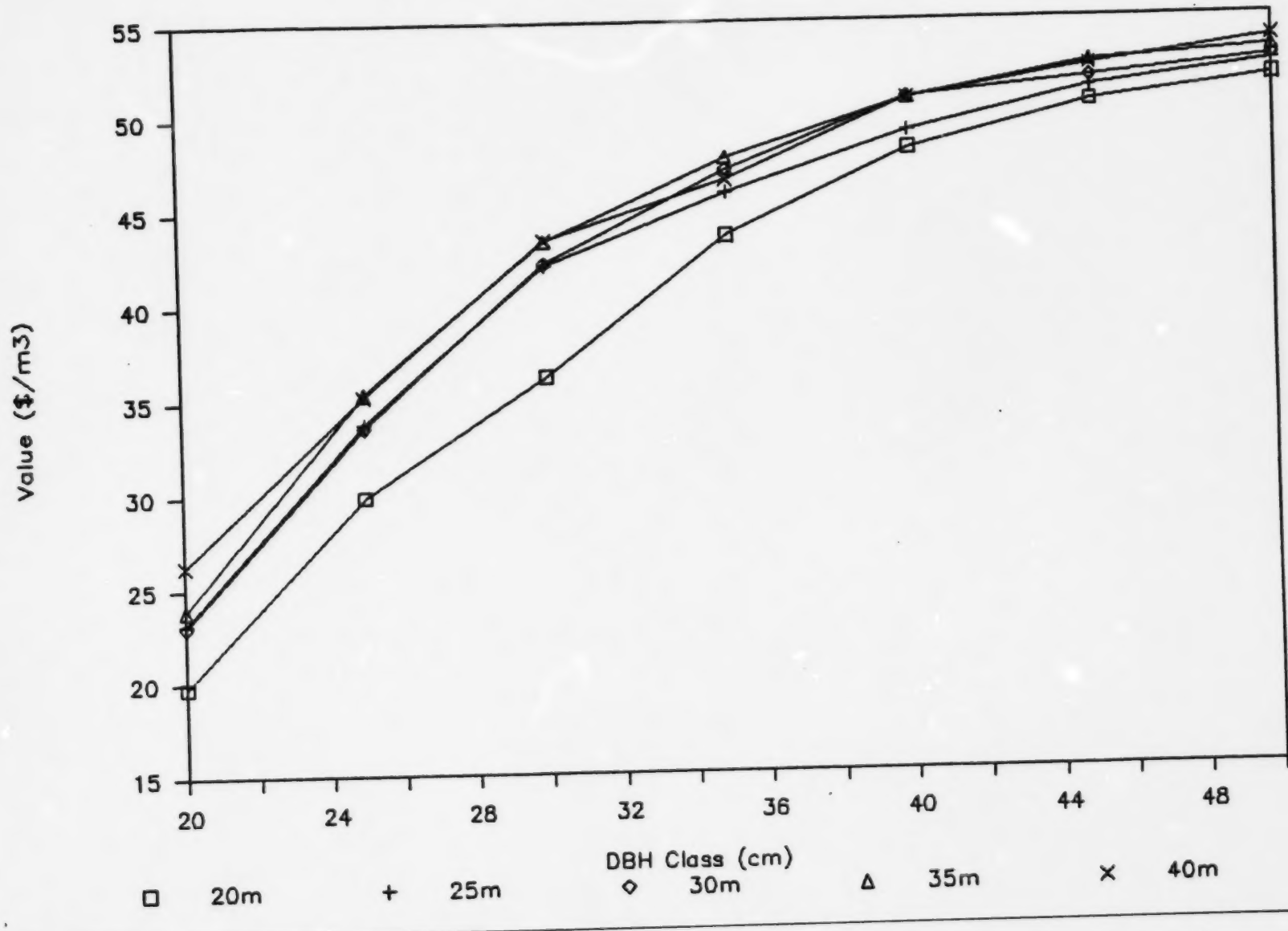


Fig. 10

5.13 Coastal Douglas-fir

STEM VALUE ($ per whole stem)

DBH	Tree height in metres				
(cm)	20	25	30	35	40
20	$4.04	$5.95	$7.16	$8.30	$9.34
25	9.54	12.25	14.32	16.44	19.36
30	16.01	21.09	25.00	29.40	33.48
35	25.16	32.01	38.43	44.90	50.66
40	37.31	46.78	55.95	64.29	73.18
45	49.82	61.17	72.86	85.48	96.15
50	63.54	78.06	92.32	107.47	122.98

STEM VALUE ($ per cubic metre)

DBH	Tree height in metres				
(cm)	20	25	30	35	40
20	$21.64	$23.31	$23.62	$24.09	$23.84
25	27.30	29.15	28.78	28.76	29.86
30	30.82	33.83	33.85	34.72	34.80
35	34.94	37.12	37.96	38.32	37.91
40	40.25	41.02	41.97	41.58	41.73
45	42.17	41.98	42.93	43.44	43.11
50	43.35	43.04	43.86	44.11	44.38

STERLING WOOD GROUP INC.

DOUGLAS–FIR LOG MODULE VALUES ($/m3)

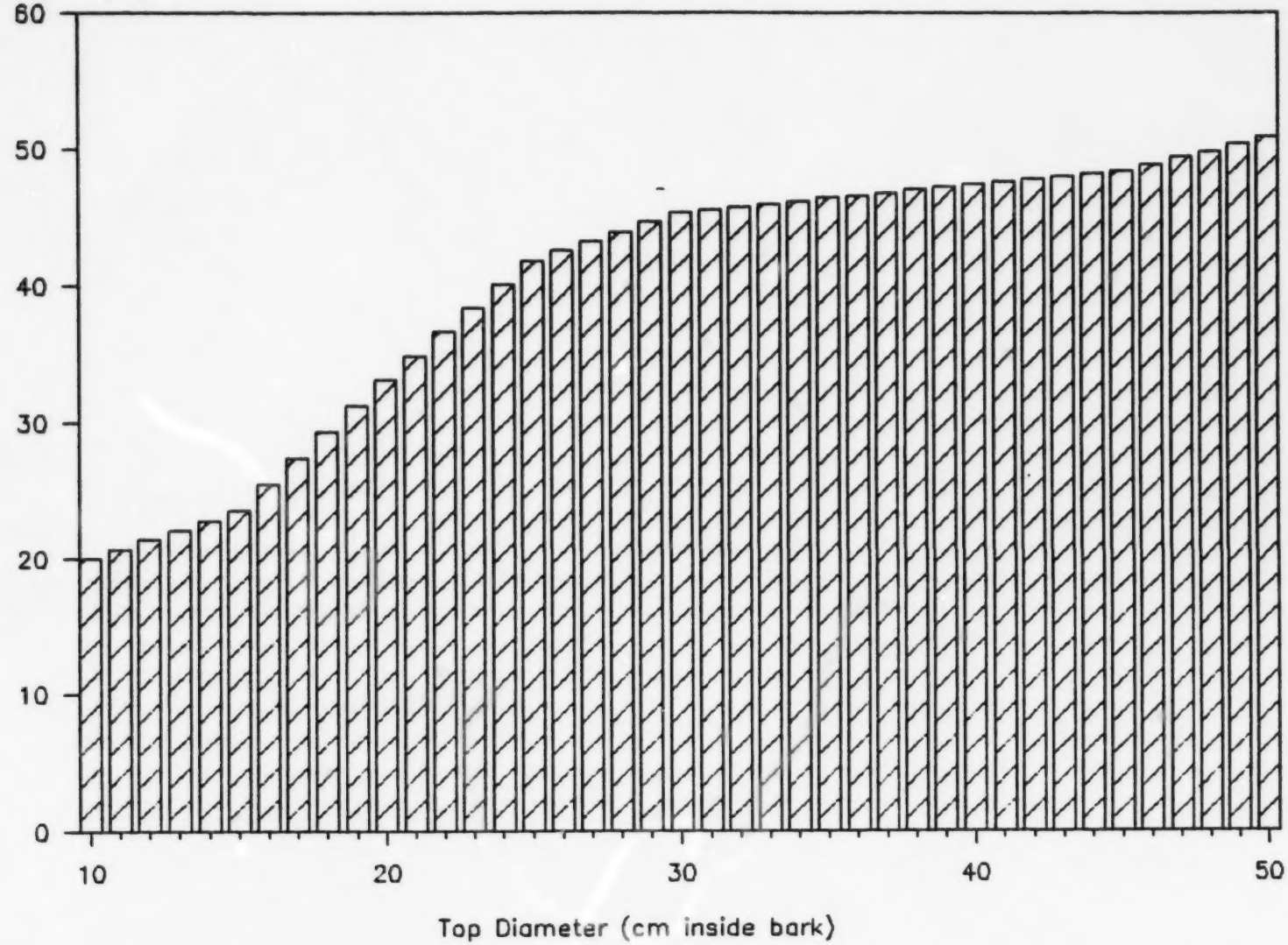


Fig. 11

STERLING WOOD GROUP INC.

DOUGLAS-FIR STEM VALUES

(WHOLE STEMS)

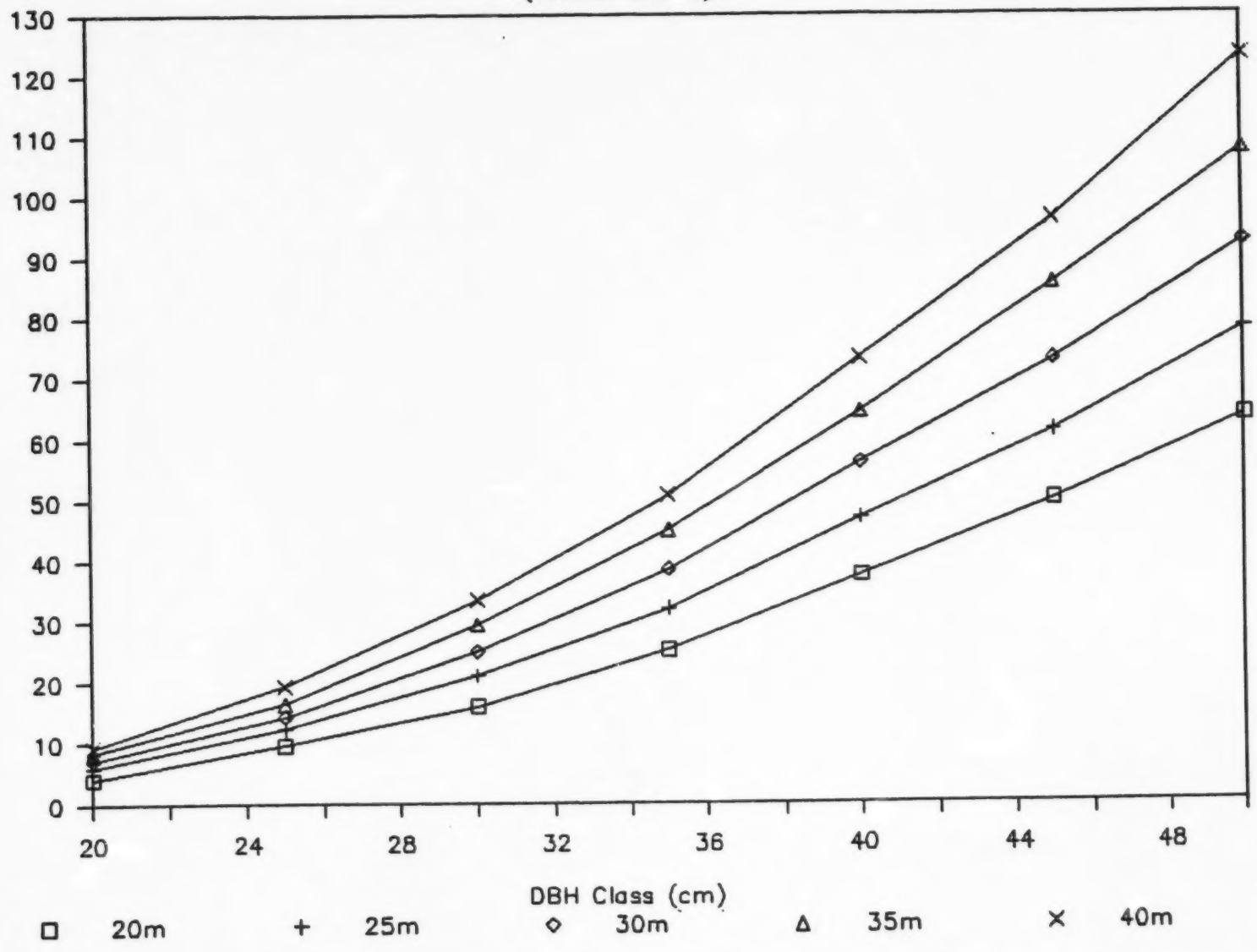


Fig. 12

STERLING WOOD GROUP INC.

DOUGLAS-FIR STEM VALUES ($/m3)

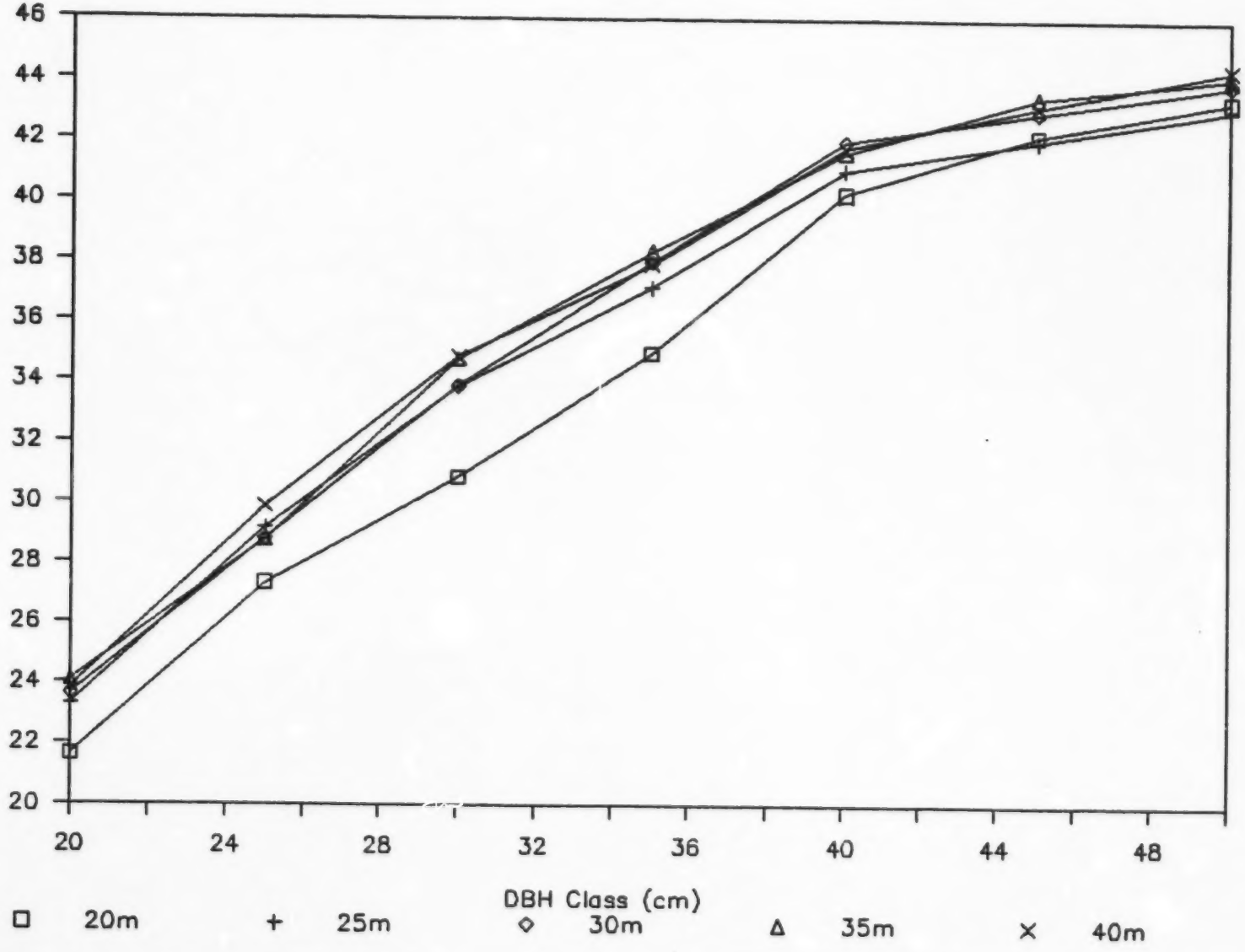


Fig. 13

5.14 Coastal Western Hemlock

STEM VALUE ($ per whole stem)

DBH	Tree height in metres				
(cm)	20	25	30	35	40
20	$ 4.78	$ 6.73	$ 8.27	$ 9.52	$10.99
25	10.33	13.33	15.72	18.57	21.03
30	16.87	21.92	25.95	30.57	34.62
35	26.38	32.43	39.07	45.17	50.59
40	36.50	45.09	53.36	62.72	70.74
45	47.04	59.82	70.60	80.08	91.43
50	59.08	75.28	90.58	101.20	114.97

STEM VALUE ($ per cubic metre)

DBH	Tree height in metres				
(cm)	20	25	30	35	40
20	$25.51	$26.37	$27.70	$27.64	$28.25
25	29.56	31.72	31.60	32.50	32.43
30	32.47	35.16	35.14	36.10	35.98
35	37.69	37.61	38.62	38.55	37.85
40	39.38	39.54	40.02	40.57	40.34
45	39.81	41.05	40.65	40.70	40.99
50	40.31	41.54	41.92	41.54	41.49

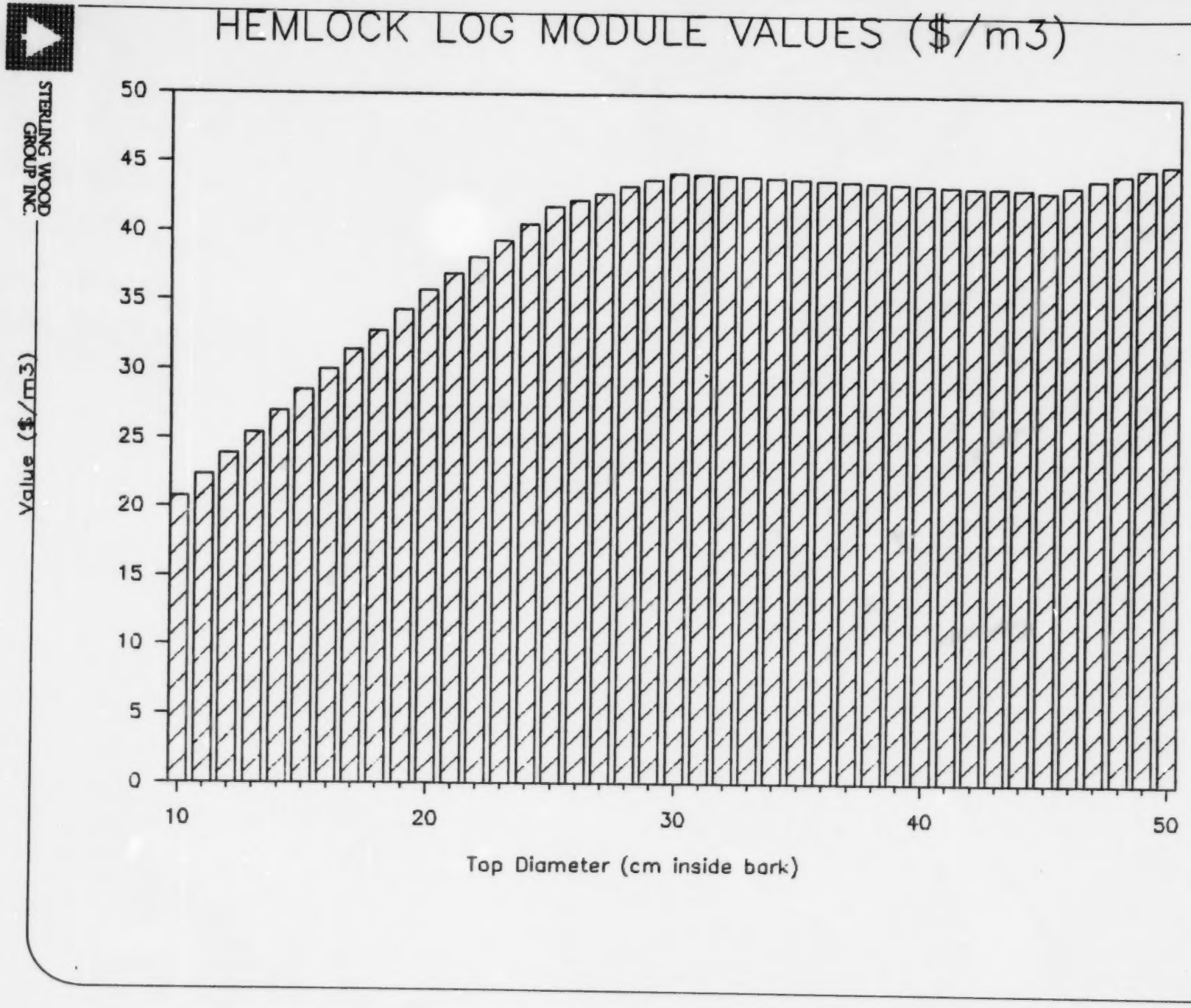

HEMLOCK LOG MODULE VALUES ($/m3)
STERLING WOOD GROUP INC.
Value ($/m3)
50
45
40
35
30
25
20
15
10
5
0
10
20
30
40
50
Top Diameter (cm inside bark)

Fig. 14

STERLING WOOD GROUP INC.

HEMLOCK STEM VALUES

(WHOLE STEMS)

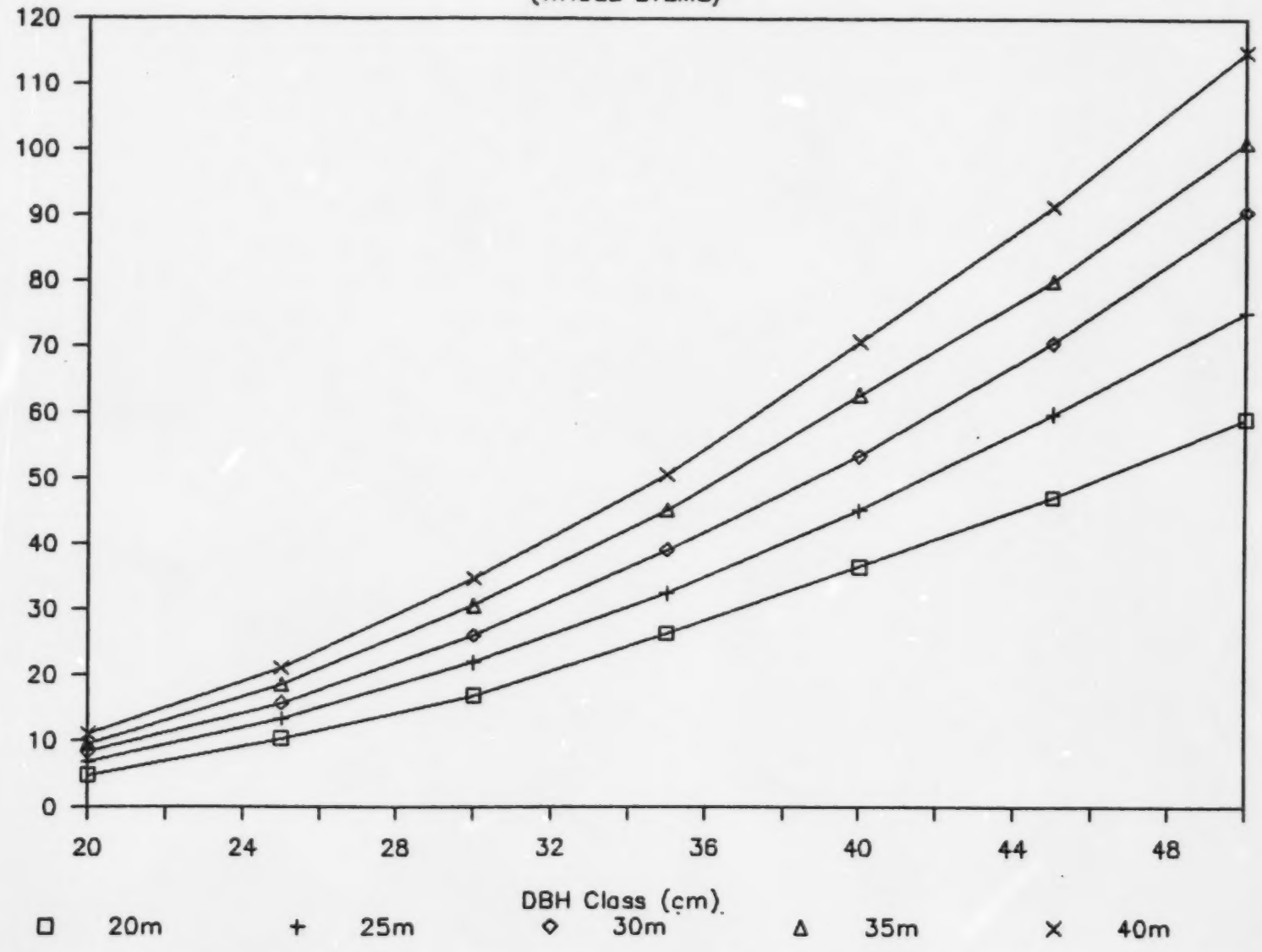


Fig. 15

37

STERLING WOOD GROUP INC.

HEMLOCK STEM VALUES ($/m3)

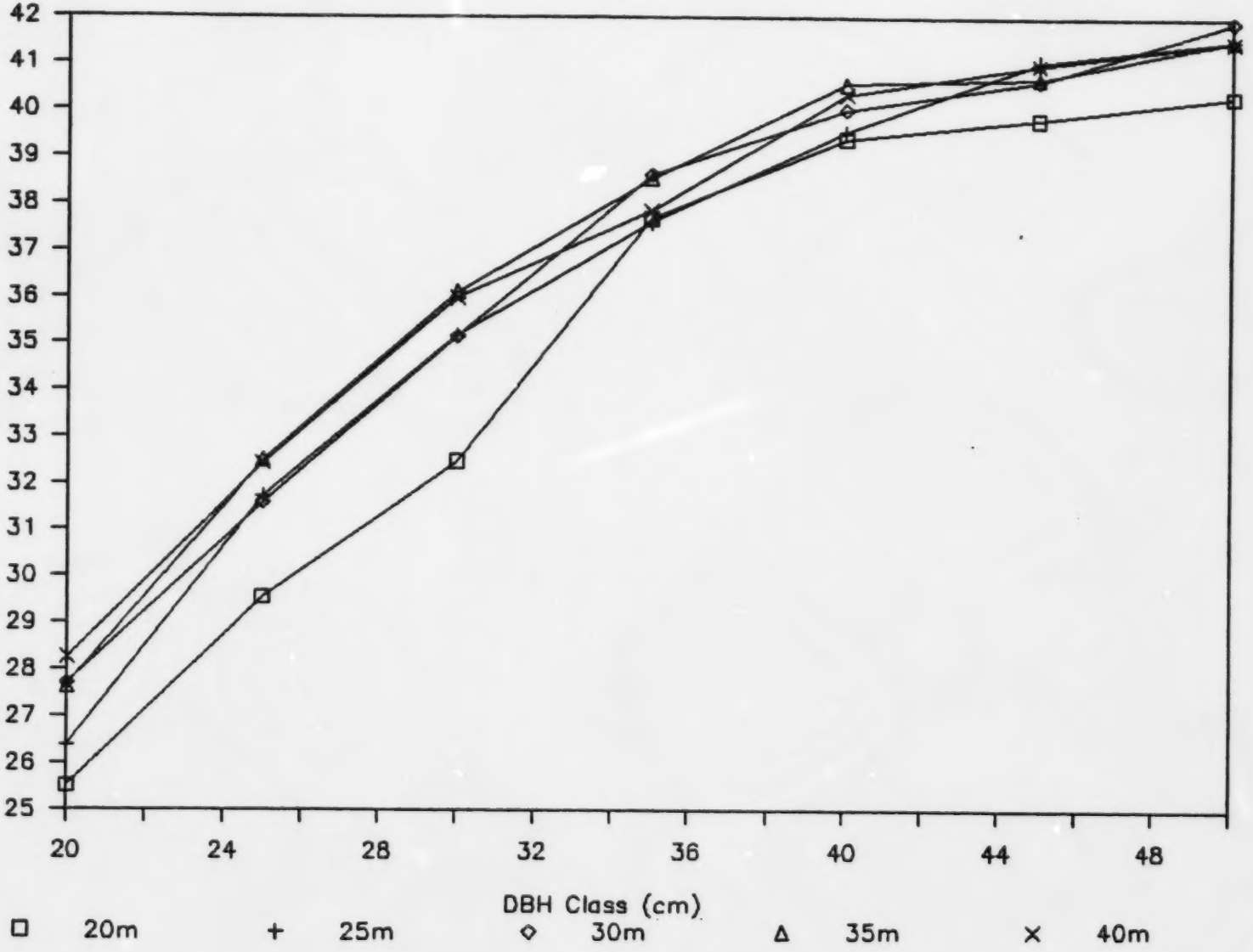


Fig. 16

5.15 Sitka Spruce

STEM VALUE ($ per whole stem)

DBH	Tree height in metres				
(cm)	20	25	30	35	40
20	$ 4.77	$ 6.80	$ 8.02	$ 9.32	$10.77
25	9.96	12.51	14.78	17.28	19.58
30	15.75	19.96	23.65	27.72	31.47
35	23.21	29.53	35.49	41.03	46.60
40	33.60	40.72	49.46	56.78	64.62
45	45.11	55.09	66.17	75.93	86.03
50	58.57	69.93	85.76	98.67	111.08

STEM VALUE ($ per cubic metre)

DBH	Tree height in metres				
(cm)	20	25	30	35	40
20	$25.56	$26.64	$26.60	$26.67	$27.68
25	28.51	29.76	29.69	30.24	30.20
30	30.32	32.02	32.03	32.74	32.70
35	32.23	34.25	35.08	35.02	34.87
40	36.25	36.15	37.10	36.73	36.85
45	38.18	38.04	38.98	38.58	38.57
50	39.96	40.25	40.74	40.54	40.09

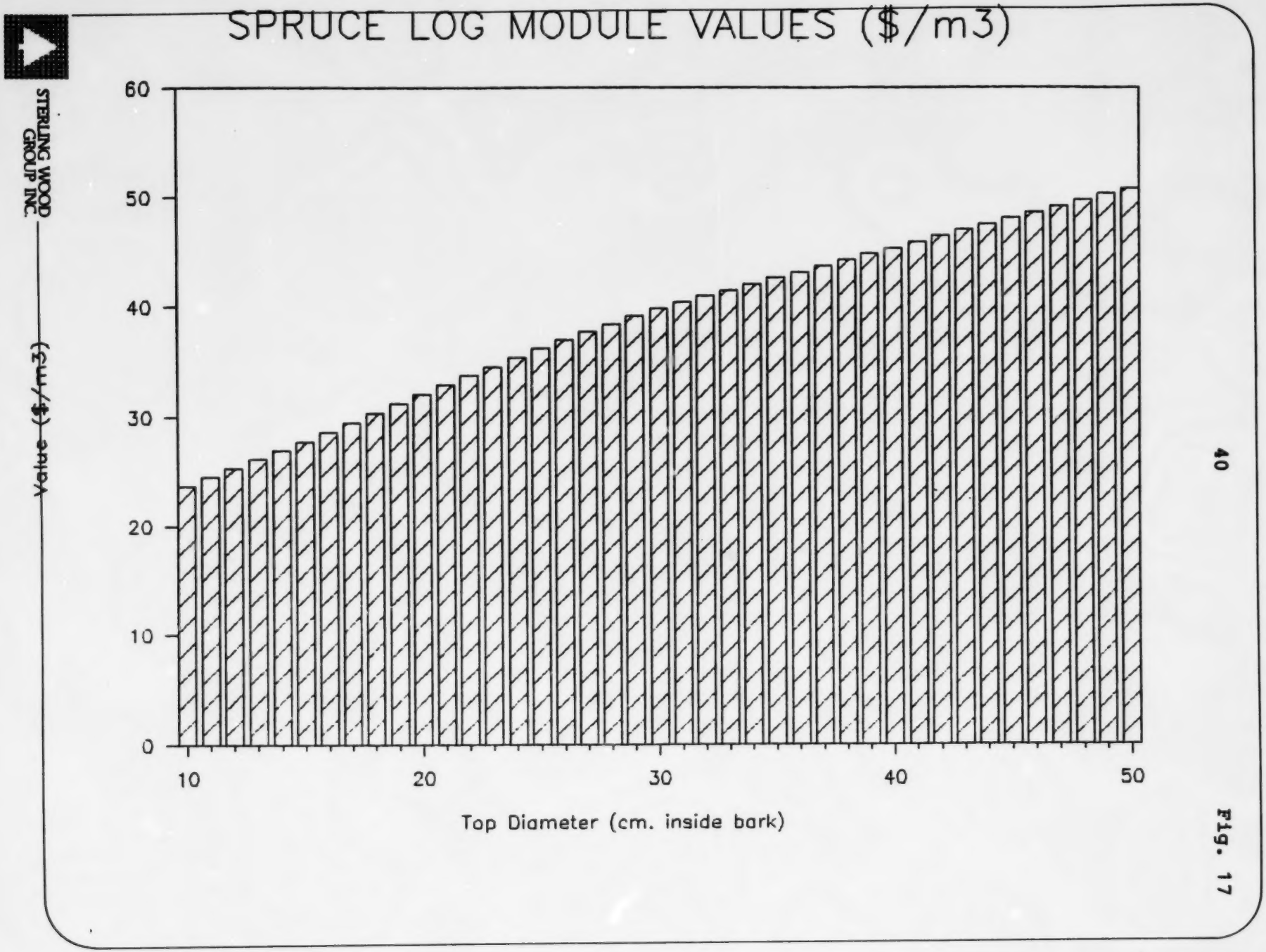

SPRUCE LOG MODULE VALUES ($/m3)
STERLING WOOD GROUP INC.
Value ($/m3)
60
50
40
30
20
10
0
10
20
30
40
50
Top Diameter (cm. inside bark)

Fig. 17

STERLING WOOD GROUP INC.

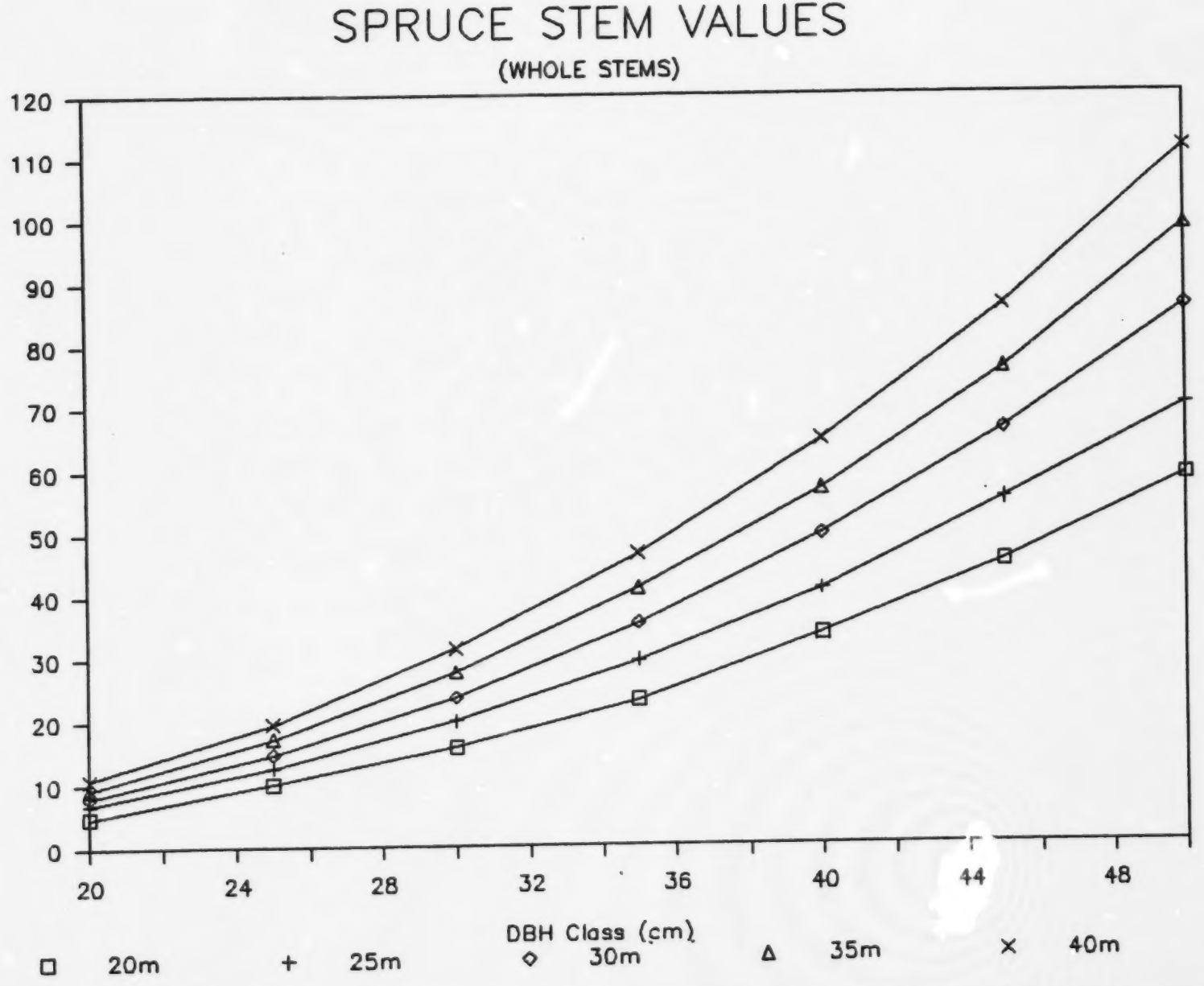


Fig. 18

STERLING WOOD GROUP INC.

SPRUCE STEM VALUES ($/m3)

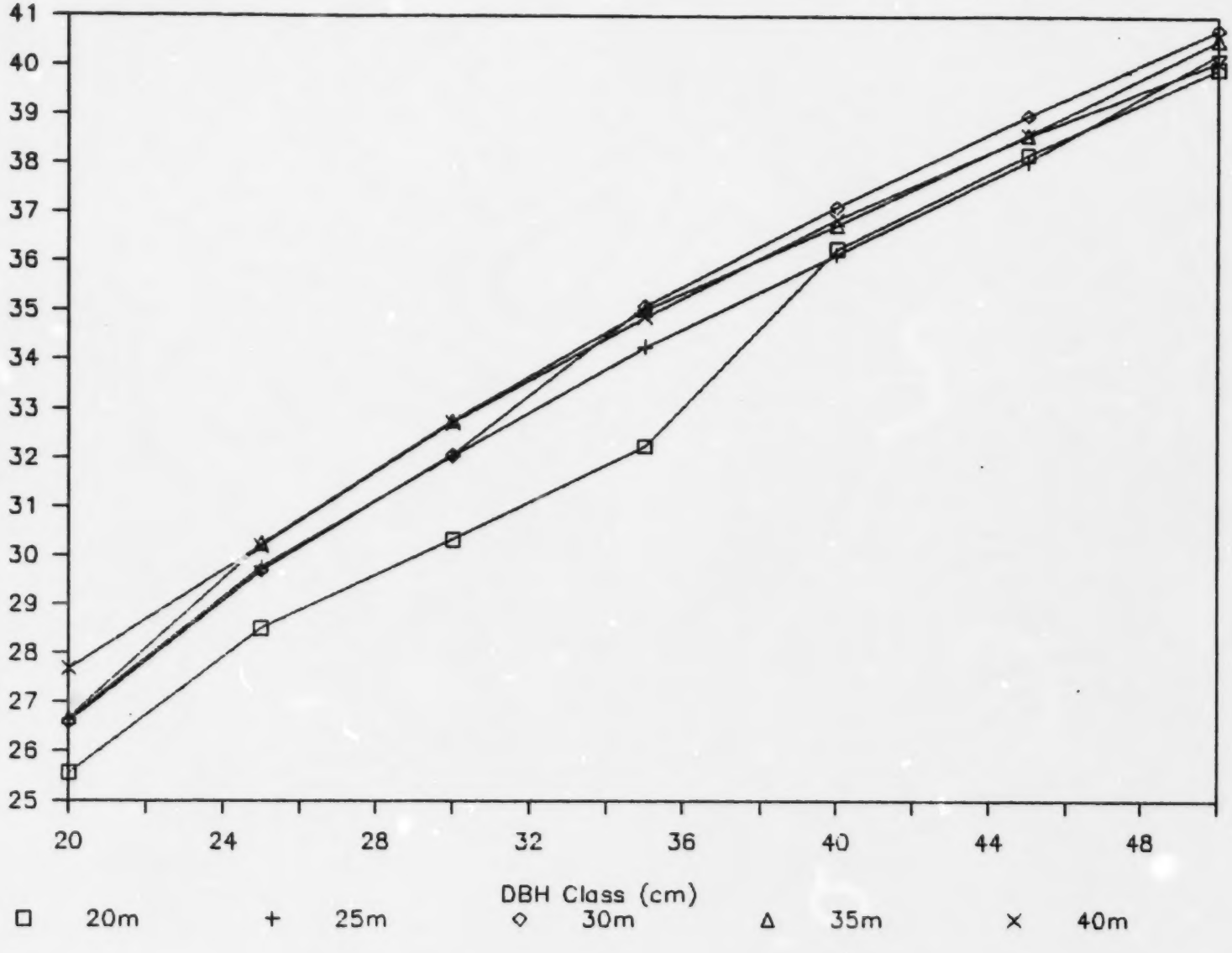


Fig. 19

5.2 Determination of Stem Values for the Interior

Value relationships to diameter and height for interior stems were found to be similar to those for the coast. This outcome partially confirms the results, inasmuch as the methodologies employed to determine log module values were quite different between the coast and the interior. Recall, coast values were based on log market prices, while interior values were based on end product (lumber and chip) values.

An ambiguity concerning conversion costs for smallwood led to the sensitivity analysis found in Appendix III. When conversion costs were increased from 0% to 50% through diminishing stem diameters from 18cm to 10cm, values of all stems were affected. The effect was minimal for larger stems, but brought values down as much as 21.5% for short, small diameter stems. It is noteworthy that this change resulted in bringing values of stems from 10 to 20 cm dbh more into line with those of coast logs in the same diameter range.

5.21 Interior Douglas-fir

STEM VALUE ($ per whole stem)

DBH (cm)	Tree height in metres 15	20	25	30	35	40
20	$ 4.45	$ 5.77	$ 7.18	$ 8.55	$ 9.90	$11.26
25	7.85	9.91	12.65	15.16	17.44	19.99
30	12.04	15.84	19.39	23.25	27.01	30.63
35	17.05	22.56	28.60	34.19	39.61	45.30
40	23.31	32.18	40.42	47.88	56.21	63.87
45	31.86	43.61	54.03	65.13	74.90	85.83
50	42.99	55.98	69.88	82.98	96.27	109.64

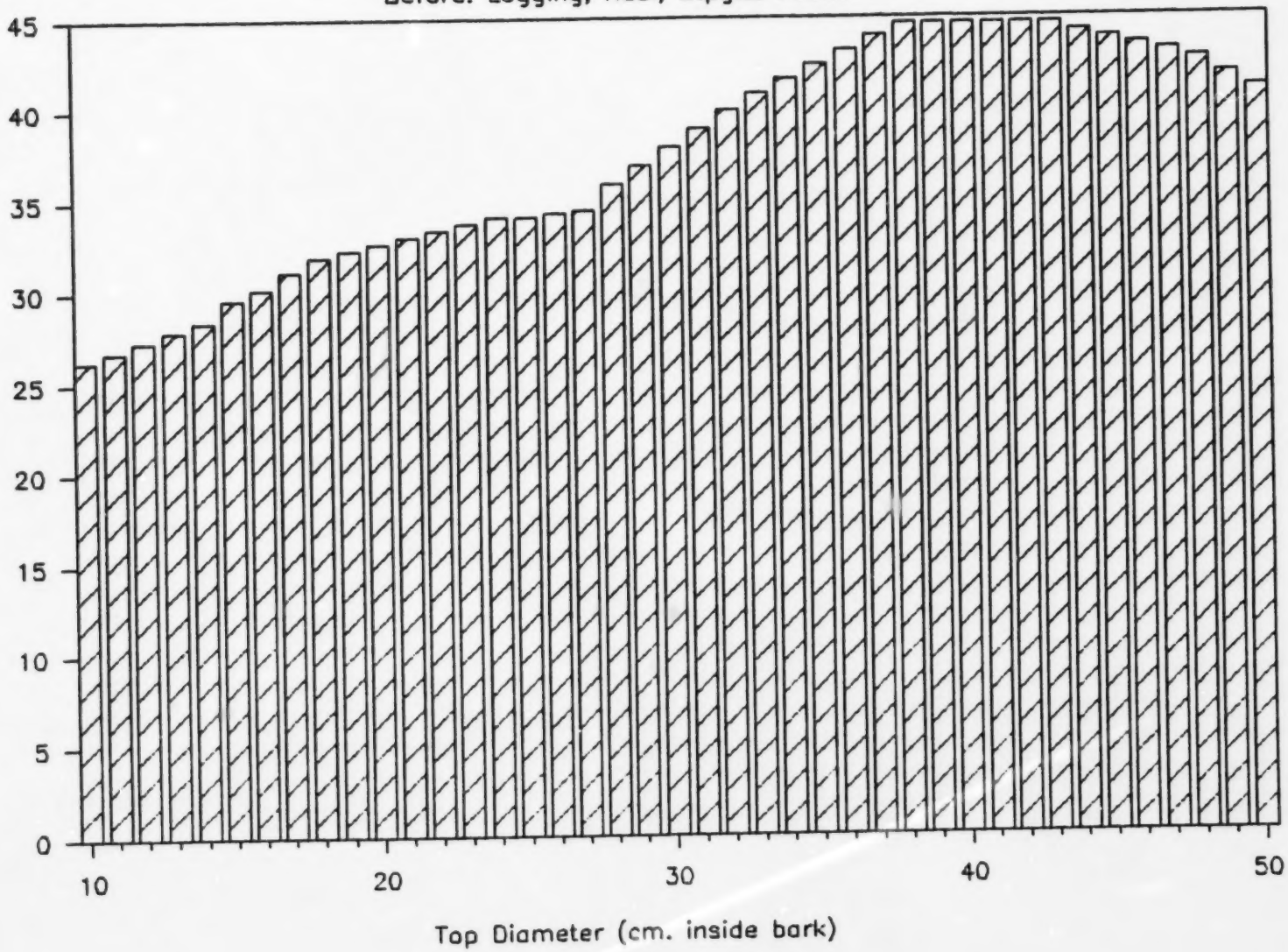
STEM VALUE ($ per cubic metre)

DBH (cm)	Tree height in metres 15	20	25	30	35	40
20	$27.94	$28.21	$28.74	$28.94	$29.03	$29.11
25	29.88	29.30	30.54	30.92	30.77	31.09
30	31.12	31.75	31.71	32.10	32.25	32.22
35	32.01	32.83	33.94	34.24	34.30	34.55
40	33.31	35.61	36.47	36.45	37.01	37.03
45	35.83	37.98	38.36	39.01	38.79	39.15
50	39.07	39.39	40.08	40.15	40.28	40.39

STERLING WOOD GROUP INC.

INTERIOR D-FIR FIVE METRE MODULE VALUES

Before: Logging, Haul, Stpg.& Profit



INTERIOR DOUG.–FIR STEM VALUES ($/stem)

Before: Logging, Haul, Stpg. & Profit

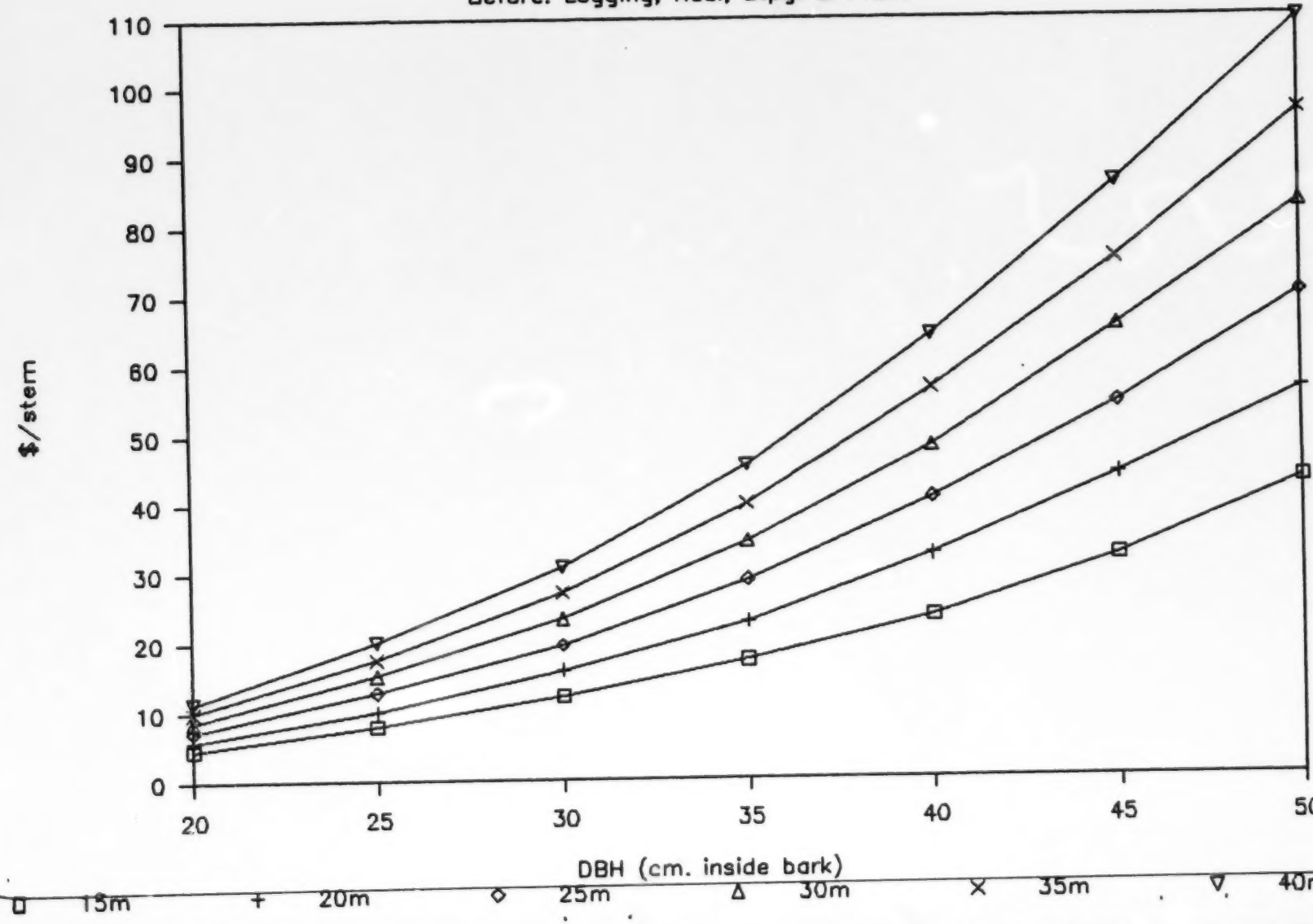


FIG. 21

STERLING WOOD GROUP INC.

INTERIOR DOUGLAS–FIR STEM VALUES ($/m3)

Before Logging, Haul, Stpg.& Profit

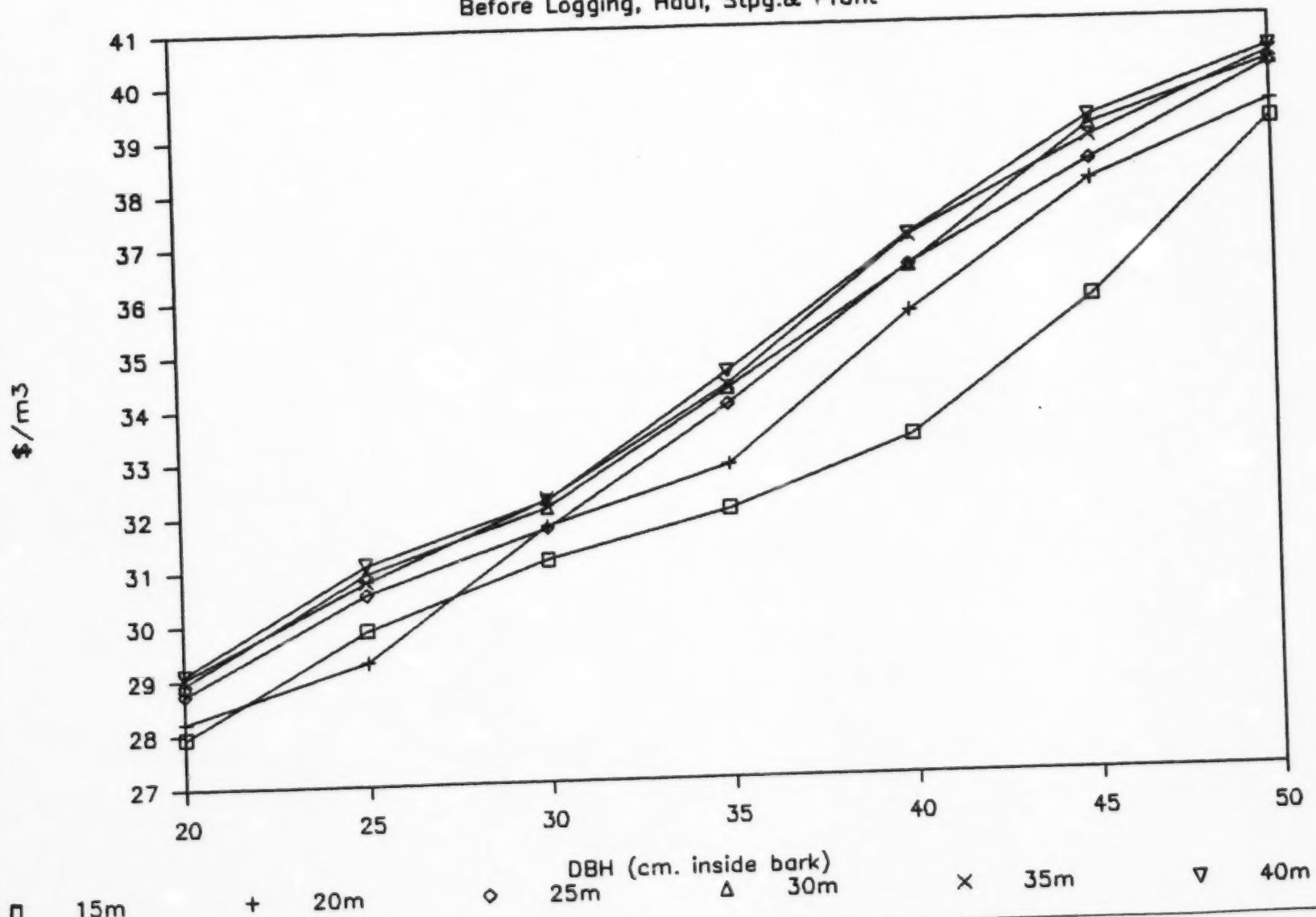


Fig. 22

5.22 Interior Spruce / Pine / Fir (spf)

STEM VALUE ($/whole stem)

DBH (cm)	Tree height in metres 15	20	25	30	35	40
20	$ 3.26	$ 4.15	$ 5.19	$ 6.16	$ 7.14	$ 8.09
25	5.60	7.16	9.03	10.81	12.49	14.25
30	8.54	11.27	13.83	16.51	19.19	21.79
35	12.13	15.95	20.25	24.18	27.97	32.01
40	16.54	22.65	28.49	33.68	39.44	44.80
45	22.54	30.52	37.64	45.36	52.30	59.82
50	30.03	38.93	48.55	57.73	66.76	75.99

STEM VALUE ($/cubic metre)

DBH (cm)	Tree height in metres 15	20	25	30	35	40
20	$20.45	$20.32	$20.76	$20.83	$20.94	$20.92
25	21.32	21.16	21.80	22.04	22.04	22.17
30	22.08	22.60	22.61	22.80	22.92	22.92
35	22.78	23.21	24.03	24.21	24.22	24.42
40	23.61	25.07	25.70	25.64	25.97	25.98
45	25.35	26.58	26.72	27.17	27.09	27.29
50	27.29	27.39	27.85	27.93	27.93	28.00

STERLING WOOD GROUP INC.

SPF FIVE-METRE MODULE VALUES ($/m3)

Before: Logging, Haul, Stpg.& Profit

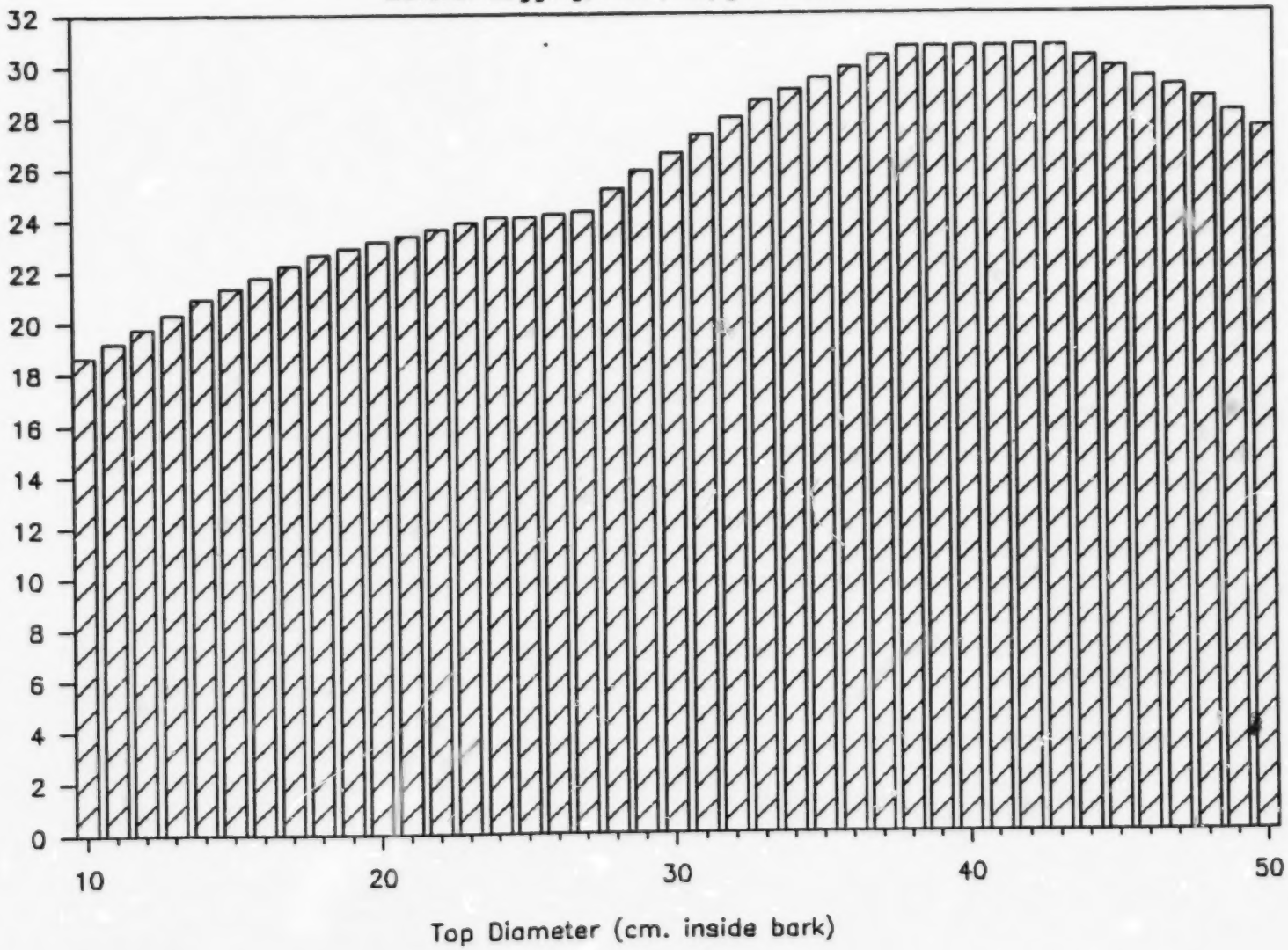


Fig. 23

STERLING WOOD GROUP INC.

SPF STEM VALUES ($/stem)

Before: Logging, Haul, Stpg.& Profit

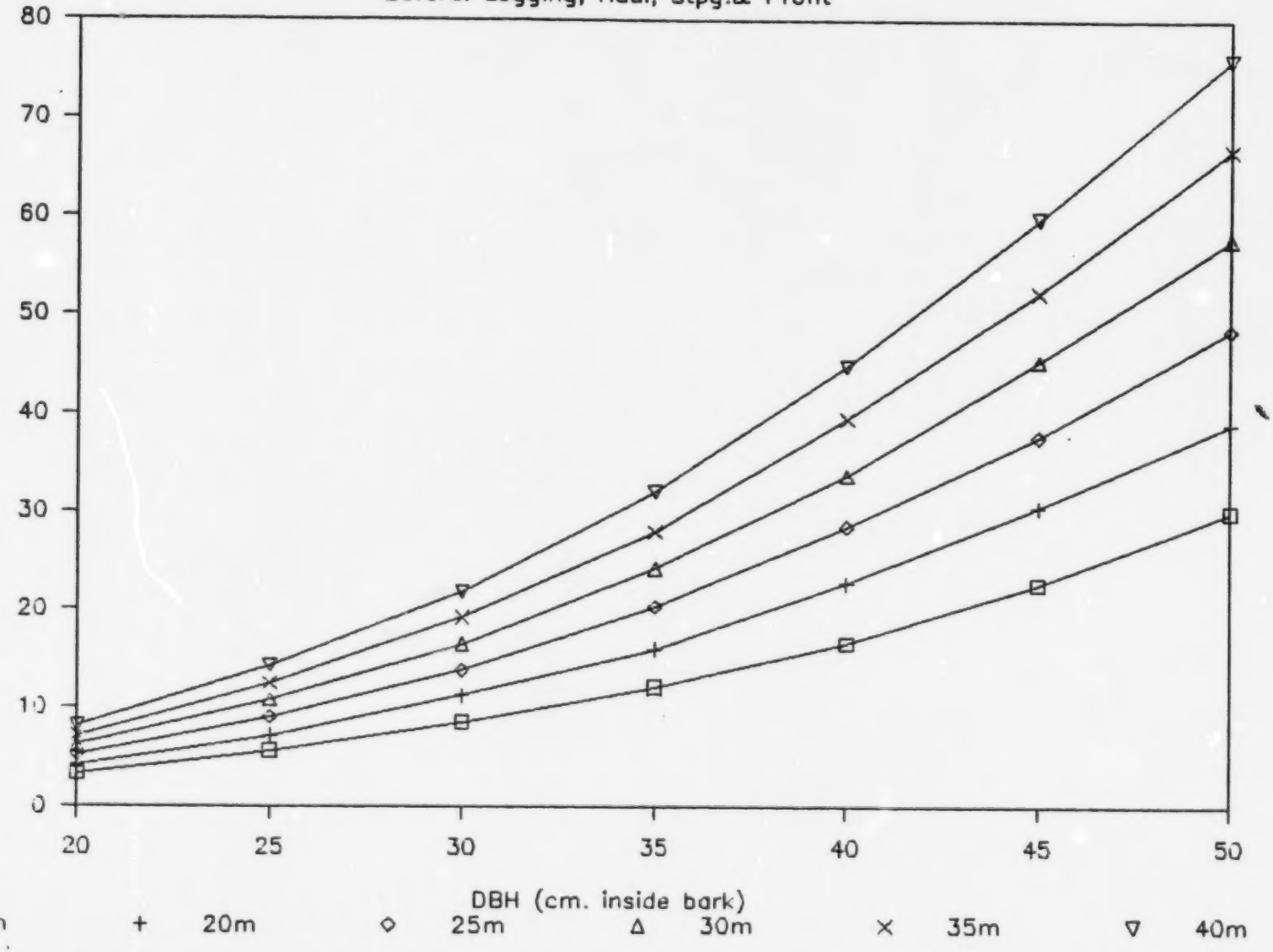


Fig. 24

STERLING WOOD GROUP INC.

SPF STEM VALUES ($/m3)

Before: Logging, Haul, Stpg. & Profit

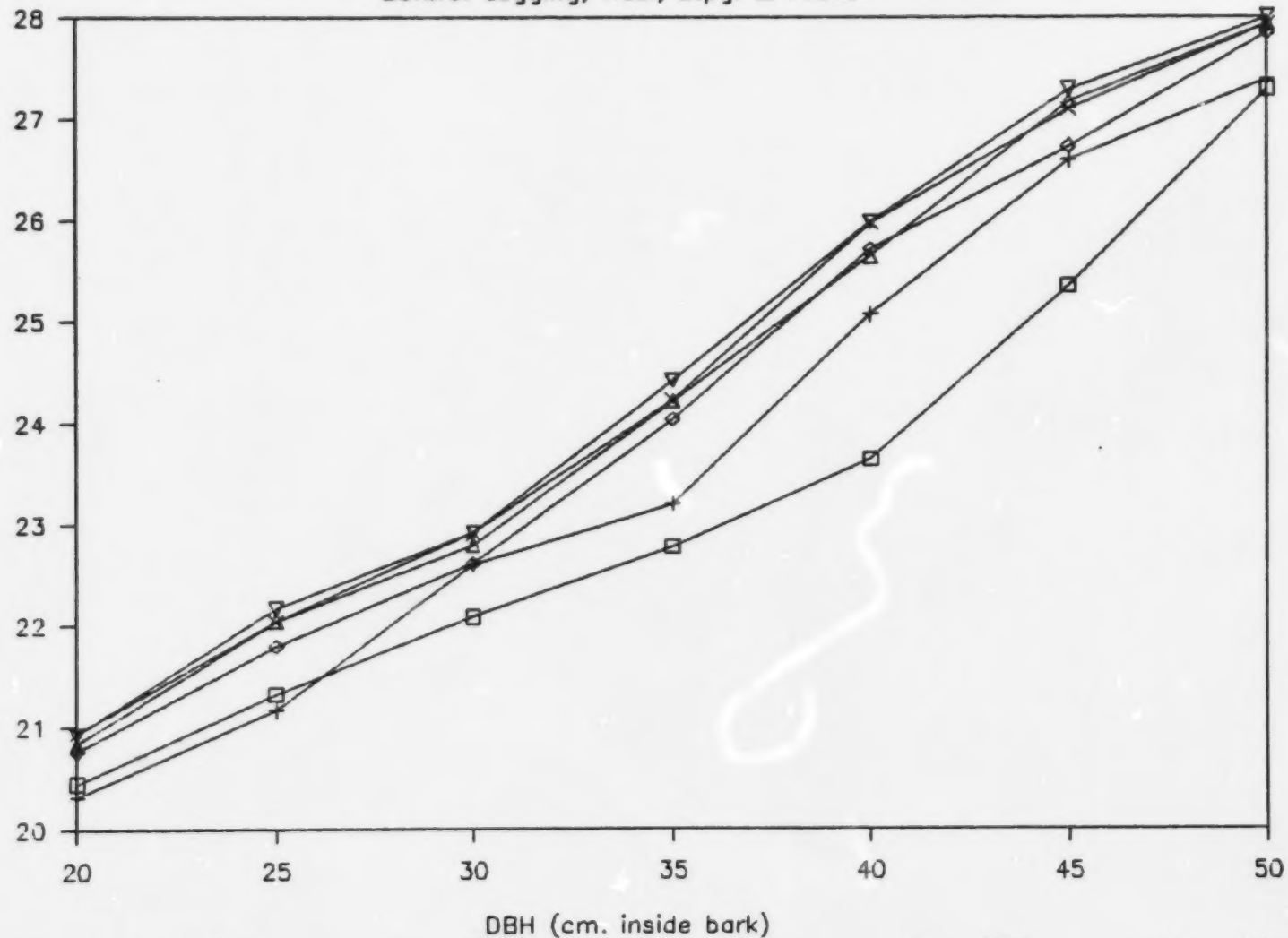


Fig. 25

5.3 Determination of Clear Wood Values

The financial benefits of pruning Douglas-fir to achieve recovery of clear lumber were also examined on a hypothetical basis. Results are expressed as the percentage value increase to the stem assuming it was pruned to a height of 5.2m. The user of these tables must first determine the percentage value increase to the 5.2m pruned butt log, a function of the width of clear collar and the stem diameter, which in turn will permit calculation of clear lumber or veneer recovery expectancy. Knowing this percentage, a value increment to the stem can be interpolated from the tables.

Percentage value improvement tended to decrease with lower stem taper and with increased stem height. These trends are a function of the proportion of the stem volume contained in the butt log of fixed length. The fixed length of the butt log also caused fluctuations to occur in value increment trends because this measure compromised optimum bucking for log diameter values. This anomoly was most evident in short stems.

PERCENTAGE STEM VALUE PREMIUMS RESULTING FROM INCREMENT TO BUTT LOG VALUE THROUGH PRUNING

TABLE 5.31

Butt Log Value Increment = 15%

dbh	20 m	25 m	30 m	35 m	40 m
20	11.8%	8.1%	8.3%	7.5%	6.6%
25	9.7	5.7	8.3	7.2	5.5
30	11.5	7.5	7.3	6.9	4.8
35	4.3	6.0	5.3	6.4	5.1
40	10.0	5.5	6.6	6.7	5.7
45	8.2	8.0	7.2	5.7	4.5
50	9.9	8.6	7.0	5.4	3.4

TABLE 5.32

Butt Log Value Increment = 30%

dbh	20 m	25 m	30 m	35 m	40 m
20	22.5%	17.5%	16.9%	15.0%	13.4%
25	20.6	15.1	16.9	14.7	12.4
30	22.9	16.9	15.7	14.5	11.3
35	15.0	15.0	12.8	13.1	11.1
40	20.3	14.0	13.9	13.1	11.4
45	18.0	16.4	14.4	11.9	10.1
50	19.6	16.9	14.1	11.7	9.0

TABLE 5.33

Butt Log Value Increment = 45%

dbh	20 m	25 m	30 m	35 m	40 m
20	33.1%	26.8%	25.6%	22.5%	20.1%
25	31.5	24.4	25.5	22.3	19.2
30	34.3	26.3	24.0	22.2	17.8
35	25.7	24.0	20.3	19.7	17.2
40	30.5	22.4	21.2	19.6	17.2
45	27.9	24.8	21.6	18.2	15.7
50	29.3	25.2	21.3	17.9	14.6

TABLE 5.34

Butt Log Value Increment = 60%

dbh	20 m	25 m	30 m	35 m	40 m
20	43.7%	36.2%	34.2%	30.1%	26.9%
25	42.5	33.8	34.1	29.9	26.0
30	45.7	35.6	32.4	29.8	24.2
35	36.5	33.0	27.8	26.4	23.2
40	40.8	30.9	28.4	26.1	22.9
45	37.7	33.2	28.8	24.4	21.4
50	39.0	33.5	28.4	24.1	20.1

TABLE 5.35

Butt Log Value Increment = 75%

dbh	20 m	25 m	30 m	35 m	40 m
20	54.4%	45.6%	42.8%	37.6%	33.7%
25	53.4	43.1	42.7	37.5	32.8
30	57.1	45.0	40.7	37.5	30.7
35	47.2	42.0	35.3	33.1	29.3
40	51.0	39.3	35.7	32.6	28.7
45	47.6	41.6	36.0	30.7	27.0
50	48.7	41.8	35.5	30.4	25.7

6.0 VALUE TRENDS

The project requires comments on several factors which may in future impact on value trends affecting components in the preceding graphs and tables. Such comments require subjective forecasting which in turn requires judgement of undefinable future expectations and therefore, the following comments are entirely our own.

6.1 Transition to Second-growth Timber

"Second-growth" merchantable timber has mostly originated through natural regeneration on a variety of lands denuded by land clearing, logging, fire, windfall or insect attack. Virtually without exception in British Columbia, these are historically unmanaged timber stands which are now reaching merchantability. Examples of utilization of these stands occur throughout the province (for example 40-year old Douglas-fir on Vancouver Island originating on formerly logged lands and 65-year old insect infested lodgepole pine in the East Kootenay originating on formerly burned lands). The significance of these stands is that they are currently being harvested economically at no older than future presumed rotation ages. The accelerating trend toward harvest of these stands is especially evident in the lower coastal area of the province. The reasons for this are the very favourable terrain, infrastructures and transportation factors which produce high conversion returns despite relatively low selling prices. Utilization of these stands is well underway and will continue to accelerate as old-growth diminishes, immature age classes achieve physical merchantability and the persistent factor of technological refinement for logging and manufacture of smaller diameter timber continues.

Prediction of products and values from these stands in future is not possible. However, the present relative values contained in the currently merchantable second-growth stands is probably the best indication of future relative values that exists. Absolute values for prediction purposes can be adjusted anytime on the basis of the tables in this report by a simple factoring process whenever a change in component value is determined. In our opinion probable value changes will occur in managed and unmanaged stands for factors of:

* Increasing emphasis on physical testing in order to grade dimension lumber according to its mechanical properties (i.e. stress-rated grades) compared to visual grades especially as this relates to juvenile wood inclusions. In this regard the following reference is quoted:

  "A considerable amount of high quality wood is lost to end uses that do not require exceptional performance (Douglas-fir). Lumber is commonly sold as an aggregate grade, #2 and better, to the housing market and includes much wood that exceeds the quality needs of that end use. More precise methods of grading such as stress grading will provide the means to supply the requirements of the housing industry and allow the extraction of higher quality to be marketed more efficiently, thus improving return on silvicultural investment." (Johnson, J.A., Wood Quality and its Relationship to Uses, Grades and Prices: Past, Present and Future.)

* Increasing emphasis on various forms of re-constituted wood products ranging from structural "lumber" to fibre boards which will tend to lessen preferred tree size requirements and hence rotation ages.

* Increasing emphasis on the simple production of pulp fibre and a consequent price trend whereby so called by-products (i.e. pulp chips) will be priced at the cost of round wood.

* Traditional supply of clear lumber from old-growth harvest will diminish, invoking a corresponding increase in the premium value of clear lumber from second-growth stands.

In summary:

So called second-growth is being harvested at an accelerating rate. These stands are producing some of the highest real conversion returns in the province despite relatively low selling prices. These conversion returns are partly a function of excellent terrain and logging chance, developed transportation systems and increasingly efficient logging and milling techniques. This demonstrates the excellent financial feasibility of harvest in unmanaged stands of this size of timber, even when harvest occurs well below the presumed physical rotation age. It clearly illustrates the excellent potential for intensive forest management in immature stands similarly located. Component value relationships illustrated in our report will undoubtedly change in future but we believe these will all be upward. The already demonstrated high real conversion returns and this upward value expectation are most compelling arguments for use of a large financial optimism factor by practitioners for forecasts and projections. Data based on unmanaged second-growth stands below rotation age indicates excellent financial results. It follows that managed stands should achieve even better results.

6.2 International Factors

We believe that a timber scarcity is developing world-wide and will tend over the long term to create a new, higher, base-level price structure than is evident in the historic data on which this report is based. Again, this advocates the use of an optimism factor on the part of forest management practitioners. New price levels, and hence new stem value increments, will emerge but we believe the trend will be upward in terms of absolute value. New values can be determined by factoring upward the present tabular values on the basis of the conservative but best available assumption that relative values will remain the same between log grades.

We also believe that the present impetus for more free international trade will favour British Columbia pricing levels, because of the perceived scarcity element. Trend predictions in this regard, however, are impossible because of the fluidity of interventionist motives which are always present and always politically attractive. These factors are entirely unpredictable so the best available prediction is probably a continuation of the present state.

6.3 Price Trends of Specific Value Determinants

We believe the value of aesthetically attractive "appearance" lumber products ("clears" and tight-grained "uppers") will tend to rise at an accelerating rate in future as old-growth timber supplies diminish. Although products from second-growth stands will have very different characteristics than products from old-growth stands, the increasing scarcity of the appearance grades will produce premium price differentials. We believe that the log grades

generating these products will tend to increase in value in tandem with old-growth products, although probably at a lower level. The resulting lumber grades will not be the same product but will obtain an accelerating premium price in future, depending on the development of substitutes.

We believe our tables relating to these products to be very conservative. They are based on the best available data, which is very limited, and present only the historic case. (Again, we note the existence of other data relating to old-growth appearance grade relationships which may be indicative of future second-growth log values). The appearance grade increment value tables in this report can be factored upward if the above trend becomes evident.

6.4 Survey of Predictions

The general survey of predictions within the provincial forest sector understandably provides no overall consensus. There is no general consistency of predictions but three areas warrant comment:

* There is a perception of a developing timber scarcity, but this is not unanimous.

* While not unanimous, there is consensus that product price cycles are inevitable but, despite them, there is a non-inflationary upward trend.

* There is a trend toward fibre-based and reconstituted products and to utilization of deciduous species, particularly western red alder and the aspens.

7.0 CONCLUSIONS AND RECOMMENDATIONS

The result contained in the graphs and tables of this report provide a new useable method for practitioners to forecast financial effects of certain silvicultural prescriptions.

The derivation of the value differential data was based on a simple and practical methodology and on a very limited available data base. This is an essential first step but obviously in future both sophistication of method and augmentation and refinement of the data base will be required. The process of developing more sophisticated methodologies is well underway with respect to coastal Douglas-fir. However, it is expected that there will remain a shortage of analytical capability for the Interior and for other species unless parallel work is undertaken. Much more empirically determined recovery and throughput data will be needed to verify results of models.

As a conclusion it is evident that the effect of diameter on value takes place within a narrow band of log diameters from 15 to 25 cm. It is within this range that yield of lumber increases dramatically. Between 20 and 25 cm, stem values tend to plateau and then rise again on the expectation of recovering premium lumber grades on the coast and wider dimension widths in the interior. The effect of diameter on conversion costs is relatively insignificant once the impact of value recovery has been accounted for.

With regard to trends, the conclusion is that real values are trending upward in both coniferous and certain deciduous species. This warrants use of an optimism factor by practitioners evaluating silvicultural prescriptions in coniferous stands. It also may warrant re-examination of programmes applied to certain deciduous species, notably red alder and poplar species.

APPENDIX I

LIST OF COMPANIES, ORGANIZATIONS AND INDIVIDUALS CONSULTED

B.C. Ministry of Forests
- Valuation Branch
- Research Branch, Victoria and Vernon, B.C.
- Scaling, Vancouver Region

B.C. Forest Products Ltd.
Cariboo Lumber Manufacturers Association
Carroll Hatch (International) Ltd.
Council of Forest Industries of B.C.
Crown Forest Industries Ltd.
Demaerschalk, J.P. PhD.
Doman Industries Ltd.
Forest Economics and Policy Analysis Project
Forintek Canada Corp.
Leach, Howard A. P.Eng.
Lignum Sales Ltd.
MacMillan Bloedel Ltd.
Porter Engineering Ltd.
Schmidt, Ralph PhD.
Shearwater Scaling and Grading Ltd.
Statistics Canada
Terminal Sawmills Ltd.
Trans Pacific Trading
Weldwood of Canada Ltd.
Western Forest Products Ltd.
Westport Export Ltd.
Widman Management Ltd.

APPENDIX II

EXAMPLES OF DERIVATION OF STEM VALUES FOR THE COAST AND INTERIOR

Extracts from the computer model.

Table 1: Coastal Douglas-fir

Table 2: Interior Douglas-fir

Table 3: Sample Derivation of Interior Residual Value Data Point.

TABLE 1

EXAMPLE SHOWING DERIVATION OF SECOND-GROWTH STEM VALUES

SPECIES: COASTAL DOUGLAS-FIR

GRADE	Avg Log Price ($/m3)	Avg top Diam. (cm)	Diam. Limits (cm)	2nd Growth Est Value ($/m3)	INTERPOLATION OF VALUES Top Dia (cm)	Est. Value ($/m3)	Top Dia (cm)	Est. Value ($/m3)
CNS	$19.62	13		$22.00	10	$20.00	20	$33.15
J	40.87	24	10-36	40.87	11	20.70	21	34.90
GANG	49.46	28		45.00	12	21.39	22	36.65
I	58.37	48	38+/50+	49.00	13	22.09	23	38.40
H	69.59	60	30+/50+	60.00	14	22.79	24	40.15
D	119.23	90	76+		15	23.48	25	41.91
					16	25.42	30	45.40
					17	27.35	35	46.40
					18	29.28	40	47.40
					19	31.21	45	48.40
							50	50.93

DOUGLAS-FIR STEM VALUES

dbh class (cm)	tree height (m)	merch. stem (m)	taper (cm/m)		LOG 1	2	3	4	STEM VALUE $/stem	$/m3
25	40	24.2	0.646	top	10.0	14.0	18.0	22.0		
				butt	14.0	18.0	22.0	25.6		
				length	6.19	6.19	6.19	5.64		
				price	$20.00	$22.79	$29.28	$36.65		
				volume	0.07	0.13	0.20	0.25	0.648	
				VALUE	$1.44	$2.88	$5.76	$9.28	$19.36	$29.86

STEM VALUE ($ per whole stem)

dbh (cm)	height class 20 m	25 m	30 m	35 m	40 m
20	$4.04	$5.95	$7.16	$8.30	$9.34
25	9.54	12.25	14.32	16.44	19.36
30	16.01	21.09	25.00	29.40	33.48

STEM VALUE ($/cubic metre)

dbh (cm)	height class 20 m	25 m	30 m	35 m	40 m
20	$21.64	$23.31	$23.62	$24.09	$23.84
25	27.30	29.15	28.78	28.76	29.86
30	30.82	33.83	33.85	34.72	34.80

TABLE 2

EXAMPLE OF DETERMINATION OF STEM VALUES AT THE MILL GATE

Species: INTERIOR DOUGLAS-FIR

Top Diameter: 10 cm

Height Class: 40 metres

TREE DESCRIPTIONS:

dbh (cm)	taper (cm/m)	stem: top length (m)	stem: length (m)	stem: volume (m3)	stem: butt diam 0	Top Diameter of 5 m. Logs (First Log at Butt): 1	2	3	4	5	6	7
20	0.52	19.35	20.35	0.387	20.52	17.9	15.3	12.8	10.2	10.0	0.0	0.0
25	0.65	15.48	24.22	0.643	25.65	22.4	19.2	16.0	12.7	10.0	0.0	0.0
30	0.78	12.90	26.80	0.951	30.78	26.9	23.0	19.1	15.3	11.4	10.0	0.0
35	0.90	11.06	28.64	1.311	35.90	31.4	26.9	22.3	17.8	13.3	10.0	0.0
40	1.03	9.68	30.03	1.725	41.03	35.9	30.7	25.5	20.4	15.2	10.0	10.0
45	1.16	8.60	31.10	2.192	46.16	40.3	34.5	28.7	22.9	17.1	11.3	10.0
50	1.29	7.74	31.96	2.714	51.29	44.8	38.4	31.9	25.5	19.0	12.5	10.0

LOG VOLUMES (m^3)

DBH (cm)	Butt	2nd	3rd	4th	5th	6th	7th
20	0.145	0.109	0.078	0.052	0.003	0.000	0.000
25	0.227	0.170	0.122	0.081	0.043	0.000	0.000
30	0.327	0.245	0.175	0.117	0.070	0.016	0.000
35	0.445	0.334	0.238	0.159	0.096	0.039	0.000
40	0.581	0.436	0.311	0.208	0.125	0.063	0.000
45	0.736	0.552	0.394	0.263	0.158	0.080	0.010
50	0.908	0.681	0.486	0.324	0.195	0.099	0.020

VALUE OF FIVE METRE LOGS ($/pc.)

dbh	Butt	2nd	3rd	4th	5th	6th	7th	STEM VALUE: TOTAL	$/m3
20	$4.52	$3.22	$2.12	$1.36	$0.03	$0.00	$0.00	$11.26	$29.11
25	7.57	5.49	3.60	2.21	1.13	0.00	0.00	19.99	31.09
30	11.20	8.26	5.64	3.45	1.88	0.19	0.00	30.63	32.22
35	17.30	11.43	7.94	4.94	2.66	1.02	0.00	45.30	34.55
40	24.64	16.50	10.60	6.77	3.70	1.66	0.00	63.87	37.03
45	32.82	22.95	14.13	8.76	4.92	2.14	0.12	85.83	39.15
50	40.17	30.37	18.90	11.05	6.22	2.70	0.24	109.64	40.39

Table 3

SAMPLE DERIVATION OF INTERIOR RESIDUAL VALUE DATA POINT
(For logs with top diameter of 27.7 cm)

165 LOGS WITH 27.7 cm AVERAGE TOP DIAMETER (Range 25.4 to 30.2 cm)

Percentage Distribution of Lumber Grades and Sizes Recovered

Lumber Dimensions (inches)	SELECT	GRADE 1	GRADE 2	GRADE 3	GRADE 4	TOTALS
1 X 4	0.0	0.7	0.6	0.5	0.2	2.0
1 X 6	0.0	0.1	0.1	0.0	0.1	0.3
2 X 4	0.4	1.3	3.8	0.8	0.6	6.9
2 X 6	1.1	8.7	16.3	4.3	1.0	31.4
2 X 8	10.8	17.1	23.0	3.5	0.7	55.1
2 X 10	0.5	1.0	2.3	0.6	0.0	4.4
TOTALS:	12.8	28.9	46.1	9.7	2.6	100

Weighted Average Lumber Sales Return -- $/Mfbm

	SELECT	GRADE 1	GRADE 2	GRADE 3	GRADE 4	TOTALS
1 X 4	0.00	1.51	1.34	0.77	0.09	3.72
1 X 6	0.00	0.28	0.29	0.00	0.06	0.62
2 X 4	0.83	2.69	8.16	1.32	0.26	13.26
2 X 6	2.29	18.10	35.27	6.98	0.43	63.06
2 X 8	22.46	35.57	42.93	4.90	0.26	106.12
2 X 10	1.28	2.56	6.15	1.20	0.00	11.20
TOTALS:	26.86	60.71	94.15	15.17	1.10	197.98

RECOVERY		VALUE	$/m3
Lumber:	265 LRF 15047 fbm	Sales	$52.46
		chip sales +	$ 4.54 *
Chips :	21.5% Chips 0.0312 BDU/pc. 0.344 m3 per pc.	manuf. costs -	$22.26 **
		Log Value	$34.74

NOTES- * chip price = $50.00/BDU net FOB mill
** manufacturing costs = $84.00/Mfbm net of fuel values

APPENDIX III

SENSITIVITY OF STEM VALUES TO HIGH SMALLWOOD CONVERSION COSTS

The following tables show the sensitivity of Douglas-fir values to increased milling costs that may be associated with logs of small diameter. (See page 15 and the footnote on page 16).

Cost increases of 50% for logs with a top diameter of 12.5 cm. have been inserted into the consultant's computer model. As top diameter increased, the cost increase was lessened down to 0% at 18 cm. top diameter.

It was found that stem values were reduced by amounts ranging from 21.5%, for stems measuring 20 cm. dbh by 15 m tree height, to 1.0% for stems measuring 50 cm. and 40 m height. Hence, if value differentials are to be determined for stems of a size to be more commonly regarded as economically mature, the possible error attributable to underestimated small log conversion costs will be minimal.

INTERIOR DOUGLAS-FIR

(Compare these tables with table 5.21, page 44)

CHANGE IN STEM VALUE ($/whole stem)

DBH	Tree height in metres					
(cm)	15	20	25	30	35	40
20	-$0.95	-$1.25	-$1.28	-$1.38	-$1.59	-$1.77
25	-0.96	-0.83	-1.21	-1.24	-1.20	-1.56
30	-1.09	-1.08	-0.74	-1.19	-1.17	-1.10
35	-1.08	-0.75	-0.98	-1.04	-1.18	-1.23
40	-1.13	-1.04	-0.97	-1.02	-0.98	-1.17
45	-0.89	-1.13	-0.77	-1.02	-0.83	-0.94
50	-0.67	-1.18	-1.00	-1.04	-0.99	-0.77

CHANGE IN STEM VALUE ($/cubic metre)

DBH	Tree height in metres					
(cm)	15	20	25	30	35	40
20	-$6.00	-$6.09	-$5.12	-$4.69	-$4.66	-$4.59
25	-3.63	-2.44	-2.93	-2.52	-2.11	-2.44
30	-2.80	-2.16	-1.21	-1.64	-1.40	-1.16
35	-2.02	-1.09	-1.16	-1.04	-1.01	-0.93
40	-1.62	-1.14	-0.87	-0.77	-0.65	-0.67
45	-1.00	-0.98	-0.55	-0.61	-0.43	-0.43
50	-0.62	-0.83	-0.58	-0.50	-0.42	-0.28

APPENDIX IV

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